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FRESH-WATER SPRINGS IN THE OCEAN.

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THE ancient Greeks tell of a river of the Peloponnesus called Alpheus, rising in Mt. Stymphalus, flowing through Arcadia and Elis, and then making its way beneath the Mediterranean as far as Sicily, where it united with the fountain Arethusa near Syracuse. It was the love of a swain for a nymph which led to this movement, and this emotion seems to have been able to prevent the commingling of the two kinds of water where ordinarily a mixture would result. What has been narrated in fable seems to be true to-day in the existence of boiling fresh-water springs rising up persistently in the briny deep off certain shores in the Hawaiian and West India islands and elsewhere. So little is known about them that I venture to present a few facts that have fallen under my observation, in the hope that this slight contribution to hydrology may interest others and lead to important results.

The suggestion of this conclusion came from the combination of facts ascertained in different parts of the world. First of all was a study of artesian wells upon the island of Oahu.* This island has an area of about 600 square miles, an irregular four-sided figure with an extreme diametral line of 46 miles. Figure 1 represents Oahu and a few of its more general topographical features. The land rises to two mountainous ranges about 13 miles apart, parallel to each other. The Kaala or Waianae Mountains, 21 miles long, lie on the southwest side, with a culmination of 4,030 feet. The Koolau Mountains on the northeast side culminate in Konahuinui, 3,105 feet high, and a length of 37 miles; and the two parts are known as Koolauloa and Koolaupoko.

* 'Geology of Oahu,' *Bulletin Geol. Soc. America*, Vol. XI., p. 25.

The lowland between rises gradually to a watershed 888 feet above the sea. Each range represents an elongated dome composed of basaltic layers gently inclined outwards in every direction (quaquaversal). The Kaala dome originated first in igneous ejections outpouring at the bottom of the ocean; they were constantly renewed, and finally emerged above the waters. It was then exposed to the erosive influences of the rains brought by the trade-winds. The streams excavated cañons in the basalt upon both sides of the island, eating away more of the rock in certain portions than in others. After a

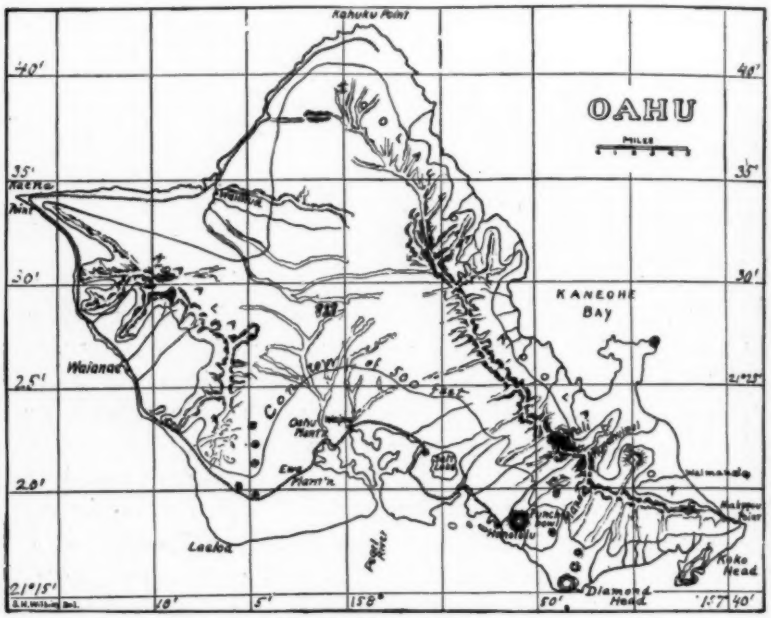

FIG 1. MAP OF OAHU.

long period a similar but longer island developed upon the eastern side, becoming the Koolau range, with more marked erosion upon the windward side, and very little upon the northern half of the leeward side. The Koolau lava poured itself out profusely, and covered up some of the earlier formed cañons upon the Kaala range.

The character of the erosion is shown in Figure 2 upon the Waianae side of the Kaala range. The cañon has been enlarged to an alcove and the precipitous side—called a *Pali* by the Hawaiians—presents a curious escalloped surface, or what might almost be called the ribs of the mountain side. Precisely similar waves appear upon the pali at the eastern side of the Koolau range. The most interesting point is at a wind-gap, 1,205 feet above the sea, the only place in the whole range where a road has been cut through from Honolulu by way of Nuuanu Valley to Kaneohe Bay. Up this valley for about eight miles about a hundred years ago King Kamehameha drove an army of his enemies,

who were crowded forward so furiously that they were precipitated down this pali of a thousand feet, where their bones could be seen till quite recently. This pali is one of the most interesting sights visited by modern tourists.

The Pliocene Tertiary.

These are quite extensive plains near the sea level composed partly of sediments derived from the decay of the basalts and other igneous products, and partly of calcareous marine deposits. Without attempting precision of delimitation, our map presents an approximate contour line of 500 feet altitude, which may represent the upper border of the terrane, which is clearly proved by its fossils to belong to the Pliocene

FIG. 2. EROSION ON THE WAIANAE SIDE OF KAALA.

Tertiary.* This band has a very variable width, dependent upon the amount of subaerial erosion, being the most extensive in valleys like those of Waianae and Waimanalo and in the more open area between the two mountain ranges. It is upon these plains that several large sugar plantations have been installed, for whose benefit numerous artesian wells have been sunk. In the southern part of Oahu there is a continuous belt of cane-fields eighteen miles in length, and averaging two in breadth to the west of the city of Honolulu. Others are near Waianae and Waialua.

The sugar plantations were at first located upon other islands of the group, as on Kauai, Hawaii and Maui, where plenty of streams of water afford plentiful supplies for moistening the soil, or to trans-

* W. H. Dall, *Bulletin Geol. Soc. America*, Vol. XI., p. 57.

port the cane from the uplands to the mills in flumes. Oahu was neglected because it is comparatively arid. Near Hilo, upon Hawaii, the rainfall amounts to 175 inches annually; in East Maui to 230 inches annually; while about Honolulu it varies from 24 to 38 inches; at Ewa and vicinity from 16 to 40 inches, and is quite variable by years, and insufficient for the growth of the cane. At first, attempts were made to supply water by irrigation. Like other cities, Honolulu receives much water from mountain streams brought by pipes for household and manufacturing purposes, as well as for the flowage of extensive tracts of rice land. The great need of water led to suggestions of an artesian supply. In 1879 James Campbell sank the first artesian well upon the island, near the Pearl River lagoon. Water commenced to flow from the depth of 240 feet, and the auger penetrated 33 feet more. The next one was sunk the following year at the mouth of Manoa Valley, where the discharge proved to be abundant from the depth of 298 feet. In the same year Judge McCully obtained a still greater supply from the depth of 418 feet. This last well was within the city limits, where it was easily seen by the public, who thoroughly appreciated its value. Many other persons followed the example of these pioneers, till now there are 195 wells upon the five leading plantations, yielding daily 287 million of gallons, and there are many more within the city limits of Honolulu.*

The Artesian Conditions.

Oahu presents two series of diversified sheets of rock dipping gently toward the sea from high central points; but the material is volcanic. In the early days successful artesian wells had been sunk through sedimentary strata, whence it was inferred that it would be useless to attempt borings in the so-called unstratified rocks. Many were dissuaded from such attempts by that consideration, yet any geologist would quickly observe the resemblance between these volcanic sheets and a nearly horizontal stratification. Nowhere is the succession of varied igneous layers better seen than on Kauai. This land is to be compared with either one of the Oahu or Maui domes; so that these latter islands may be termed *doublets*. The highest land on Kauai is at its center, Mt. Waialeale, over 5,000 feet in altitude. So far as is known no scientific explorer has yet penetrated this central point which is also commonly obscured by clouds. On the flanks of this central elevation are extensive plains gently inclined seaward and reminding one of a sedimentary fan, covered by a fertile soil. Streams have cut through these plains, displaying perhaps 200 feet thickness of alternating volcanic clays, earths or laterites and hard basalts. The diversity of the sheets is such as to give the conditions necessary for the de-

* Since this statement was made the number of wells and the consequent yield have considerably increased.

velopment of underground currents, but these are all clearly of volcanic origin, and here and there may be seen the remnants of the secondary craters whence came the ejections.

Oahu resembles Kauai in the dispersal of friable material in layers alternating with hard basalts, and adds marine accumulations to the igneous. The meteorological conditions explain the source and spread of the waters. Rain is profusely abundant on the highlands. The trade-winds, laden with moisture, drop their burdens on coming in contact with the land surfaces. The maximum rainfall is at the altitude of about 1,200 feet. The preponderance of the discharge, being upon the windward side, determines the place of the most copious streams and the more effective erosion. Hence the domes have been worn away unequally. One side may be entirely removed, and the other be scarcely affected at the surface. If the ridge is narrow at the altitude of greatest precipitation both sides will be extensively worn down. This is well shown on the Koolau upland, where the southeast end has been greatly denuded upon both sides from Mokapu point to the pali, while to the north, at a greater height, the cañons are less conspicuous on the west side.

The laying bare of the interior of the dome allows the water to sink into the pervious layers, and to flow beneath the surface towards Kaala and the southwest. Only the needful alternation of pervious and impervious strata is necessary to give rise to the subterraneous streams which will send water to the surface when pierced by the artesian wells.

The borings upon Oahu prove the alternation of basalt, clay, earth and limestone to the depth of several hundred feet. The principal water-bearing stratum is a very porous basalt, from 300 to 400 feet below the sea level by the shore. It has a hard, impervious cover, sufficiently tight to prevent the passage of water through it. The following general statements concerning the artesian conditions seem to be well established:

1. The presence of a porous water-bearing stratum beneath an impervious cover.

2. Water is reached usually at the depth of from 300 to 500 feet.

3. The water flows freely without pumping only in a narrow belt of territory adjacent to the coast line, where the surface is but slightly elevated; which is 42 feet at Honolulu, 32 feet at Ewa and 26 feet at Kahuku, at the northeast angle of the island. Wells sunk in higher ground show the water rising to the level indicated. Thus at the height of 100 feet the water will rise to the level of 42 feet at Honolulu, above which it will discharge only by the application of a pump.

4. For convenience in obtaining a proper supply several wells are sunk adjacent to each other. Naturally, as development takes place, the number of the wells increases. Thus the Ewa plantation had at first six ten-inch wells about thirty feet apart connected to a single pump,

which lifted the water about sixty feet. Later the wells are a foot in diameter in groups of ten for each pump. The water is forced through steel pipes twenty-four and thirty inches in diameter to a maximum elevation of four hundred feet. From various points ditches are dug which carry the water to every field of the plantation. The photograph, Figure 3, shows one of these pumping stations where there are twenty wells, each a foot in diameter. Though the pumps act without cessation, the water never fails; 5,000 acres of land are irrigated from these wells. The water here rises to the height of 22 feet above sea level.

5. These wells at Ewa are found to be slightly affected by the brine

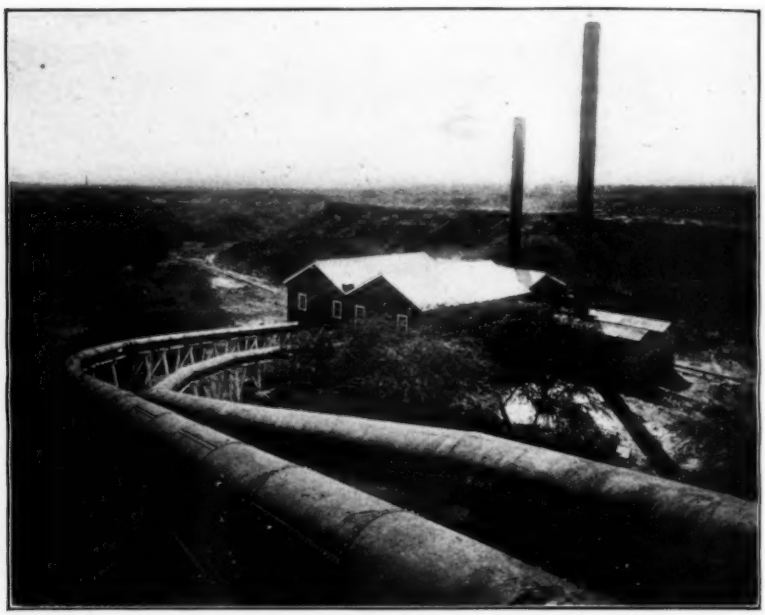

FIG. 3. EWA PLANTATION PUMPING STATION.

of the sea. The natural waters of the island contain .0073 per cent. of salt according to Dr. Walter Maxwell;* Pacific water holds 2.921 per cent. of the same. One hundred grains to the gallon of water represents 0.14 per cent. The analyst of the Ewa company found that the chlorine present (sodium chloride) was more abundant in the wells nearest the ocean. At station No. 1 the chlorine amounted to 17.61 grains in a gallon. At stations Nos. 2 and 3, farther inland, the chlorine had diminished to 8.18 and 11.97 grains to the gallon. By experiment at several localities it has been found that the salinity increases when the pumping becomes excessive. At Ewa it is stated that vegetation is not at all affected when the number of grains per

* 'Lavas and Soils of the Hawaiian Islands,' 1898.

gallon is less than sixty. At Molokai, where the salinity is greater, it is stated that the cane is not affected unless the number of grains per gallon exceeds one hundred.

From all the facts available, the conclusion seems warranted that the underground waters descend to the seas from the highlands and remain free from admixture till the pressure of the ocean exceeds that of the descending stream, when a commingling of the two liquids results. When the ocean pressure becomes greater, because of excessive pumping, the brine will increase in amount. In a small island the ocean water will force itself inland quite conspicuously. Molokai illustrates this proposition. Our information is derived from a report of Waldemar Lindgren in the Water Supply and Irrigation Papers No. 77. The springs there are of three classes, of which only the first calls for consideration here, (1) those very near the shore, (2) those breaking forth up to the height of 2,000 feet, (3) running streams still higher.

Shallow wells near the shore show the following degrees of salinity or number of grains per gallon, 238, 403, 150, 126, 109, 86, 102, 86; of deeper wells the first gave 86 grains at the surface and became ocean water at 50 feet. The second became ocean water at 125 feet. At Naiwa there are 90 grains of salinity at 70 feet. At Kalamaula several deep wells gave 102 and 104 grains and pure ocean water. The American Sugar Company sank several deep wells at Kaunakakai, of which the first five had 150 grains per gallon; others ranged from 270 to 485 grains. The Risdon wells yielded 70 to 79 grains per gallon. Better results appeared in nine wells sunk at Kawela, many of them showing less than 50 grains of salinity. The fresh water is contaminated up to four or five feet above the sea level. None of the underground streams can be more than eight miles in length, and many do not exceed three. It is also probable that no impervious layer protects the underground water as in Oahu.

6. There are springs of fresh water near the sea-shore in Oahu which may correspond to the artesian fountains. One is the famous Kamehameha Bath near Punahou, a second is near the railroad station at Honolulu, and a third gladdens the thirsty soul at Waialua near the Haleiwa Hotel. Another is at Niu, west of Koko Head. It would seem that the underground water finds it way to the surface through some crevice, after the usual manner of springs, and that it is powerful enough to prevent the commingling of the ocean water with it.

The theory of the subterranean stream from the summits to sea level has been further tested practically by the driving of tunnels to reach the water near its source. Thus derived the water is free from any possible saline contamination, and being delivered by means of a ditch sloping downwards, the expense of sinking artesian wells and the subsequent pumping is saved. In this way a copious daily flow has

been obtained from the Waianae side of Kaala, utilized to run a dynamo, besides irrigating several plantations. On Maui near Lahaina, a six-million-gallon daily flow is derived from the altitude of 2,600 feet through a tunnel of the same length. There are no springs nor other signs of underground water along the route. It must be permanent, as the flow has been constant for the past two years. Other examples could be cited.

Springs in the Ocean.

7. After so many introductory statements it is possible now to postulate the central idea of this paper: springs of fresh water arise in the midst of the ocean at some distance from the shore. The facts are not numerous, but are stated upon the best authority. Professor Joseph Le Conte, in his 'Geology,'* says that fresh-water springs arise in the ocean in the Hawaiian Islands. In reply to my inquiry as to details, he wrote that he had not preserved the memoranda relating to these phenomena, and that they had escaped his memory. No one can doubt the correctness of the statement in view of the existence of the proved underground waters. Powerful streams discharge millions of gallons of water through the artificial openings very near the sea-shore. If not intercepted, they must continue a considerable distance out to sea, and hence must well up to the surface amid saline billows.

Inquiry about these springs during the past summer in the territory of Hawaii has resulted in the discovery of several upon Oahu, there is one off Diamond Head; a second off Waialae. At the east end of Maui, in Hana, there was a fortress named Kaimuke, occupied by soldiers in the ancient times. As it was almost an island communication with the mainland was not feasible in the time of a siege, and for the lack of water it could not have been held except for the presence of submarine springs. The natives would dive down to collect water in their calabashes, which supplied all the wants of the garrison. Other springs were known in the harbor of Hana, and at low tide at Lahaina. Upon Hawadi I found there were fresh-water springs off Kawadahae and Punaluu. Further inquiry would doubtless discover many other examples.

Underground Waters in Florida.

A later residence of a few weeks in Florida proved that the characteristic fluvial phenomena cited above were even better developed there than in Hawaii. If there is anything peculiar about drinking-water one discovers it very soon, as was the case in Florida. The first feature to be noted along the eastern coast of Florida is the presence of hundreds of driven and artesian wells. Every cottage of importance derives its water for culinary and irrigating purposes from them.

* 'Elements of Geology,' p. 74.

In the Water Supply and Irrigation Papers, No. 102, Mr. M. L. Fuller, of the U. S. Geological Survey, has brought together all sorts of information about the natural and artifical sources of water of Florida, as well as of the whole eastern United States. Mr. Fuller has kindly answered my inquiries about these fresh-water springs in the ocean, stating important facts supplementary to this Water Supply Paper.

The peninsula of Florida is underlaid by Tertiary deposits of all ages, the older portions lying along the central axis, and are flanked upon both sides by the Oligocene, Miocene and Pliocene. Artesian wells are successfully operated upon both the Atlantic and Gulf coasts. The strata dip gently from the central axis towards both shores, and where there is the proper diversity of hard, soft, pervious and impervious strata the water comes to the surface without pumping. A few statements about the better known wells partly derived from original observations and partly taken from Mr. Fuller's report will be pertinent. At Jacksonville the visitors to the subtropical exposition in 1888 saw water flowing in a stream from a well several hundred feet deep, supplying the various needs of the management. Flowing wells have since then been sunk to the depths of 616, 708, 740, 800, 850, 3,000 and 5,000 feet.

At St. Augustine a well 1,500 feet deep furnishes the East Coast Hotel system with plenty of water, including a spacious swimming tank. It has a temperature of 70° F., so that bathing in it is agreeable in the coldest weather.

At Ormond there are numerous wells at comparatively shallow depths, the deepest one reaching 200 feet. At Daytona, close by, there are 400 wells from 100 to 220 feet deep. There are many others at nearly every town along the coast. At Palm Beach, close to the seashore, a well 1,200 feet deep is quite saline.

On the west coast the wells in the more northern section yield water by pumping. In Manatee County and at Fort Myers the fluid discharges in the normal way from depths exceeding 400 feet. One on the premises of T. A. Edison, the distinguished inventor, yields most abundantly from the 350-foot level, and will discharge from the height of twenty feet.

Most of these waters are characterized by the presence of sulphur, besides being warm. Chemical analyses show the presence of the following compounds: calcium sulphate, sodium chloride, sodium carbonate, calcium and magnesium carbonates, and occasionally potassium chloride and sulphate. Commonly these ingredients are so abundant as to make the water disagreeable to the taste, and when used for bathing the tubs are easily soiled, and cleansed with difficulty. When used for the table it is found expedient to allow the water to stand for

several hours before using, so that the sulphur may be volatilized and the temperature reduced.

Florida is a well watered country. Lakes, streams and springs are extremely numerous. The underlying limestone is full of caverns containing water. Every one knows about the Silver Spring in Marion County. It starts as a full-grown river from a spring 25 to 30 feet deep, perfectly clear, with an outlet 60 feet wide, 10 to 14 feet deep. It is the Oclawaha River, navigable for steamers from its very source. The water is probably the rainfall of the region filtering through miles of sand, with a temperature of 72° and perceptibly calcareous to the taste.

The water in the lakes is purer than that from the springs, probably because on exposure the compounds break up, and the gases, sulphur and hydrogen, carbonic acid, oxygen and nitrogen (common air) are eliminated. The Everglades and Lake Okeechobee illustrate this fact. The steamers plying down the Kissimmee River, across Okeechobee and down the Caloosahatchee River to Fort Myers obtain their drinking-water from far out in the lake, because nowhere else can it be found so palatable, or so well fitted for use in the boilers of the steamers.

The source of the sulphuretted hydrogen must be the various sulphates decomposed by the action upon them of organic matter. The mineral compounds arise naturally from the solubility of the various salts, either from the original strata or from their dissemination through the soil.

Fresh-water Springs in the Ocean.

Many of these underground streams proved to exist by the artesian bore-holes are of great volume, and hence must pass to some distance under the ocean. This fact is further corroborated by the small degree of salinity even in the deeper wells. Statements made by residents claim the existence of fresh-water springs miles away from the land opposite St. Augustine, Matanzas and Ormond. The first of these is also mentioned by T. C. Mendenhall, formerly superintendent of the United States Coast Survey, in a letter to J. W. Gregory, in charge of Artesian Well Investigations, Department of Agriculture.

Mr. M. L. Fuller furnishes me with the following additional localities. Dr. Mendenhall mentions the reported occurrence of fresh-water springs off the mouth of the Mississippi River. In 'The Island of Cuba,' by Lieutenant A. S. Rowan and M. M. Ramsey (Henry Holt & Co., 1896), page 18, it is stated that the water is often forced by hydrostatic pressure to the surface far out at sea. Elisée Réclus remarked that 'in the Jardines (east of the Isle of Pinos), so named from the verdure-clad islets strewn like gardens amid the blue waters, springs of fresh water bubble up from the deep, flowing probably in subterranean galleries from the mainland.'

Mr. Fuller also adds the following quotation from a paper by

himself upon the 'Hydrology of Cuba,' in the Water Supply Paper No. 110, page 93: the springs "issue at all altitudes, from the higher portions of the hills down to the lowland border, or even at sea level. . . . Not all the water comes to the surface as springs, but some passes outward and emerges from the sea bottom along the coast, where in many instances the fresh water can be seen bubbling up through the salt water. Such springs occur in Havana Harbor and at many other points. The fresh water which surges as copious springs on some of the keys is probably of the same origin, coming from the mainland through subterranean passages in the limestone."

These may be an illustration of the derivation of fresh water from the mainland upon the island of Nashawena in Buzzards Bay Massachusetts. This is a large island midway between New Bedford and Marthas Vineyard, upon which it is proposed to erect a new state prison as well as a leprosarium. Near the center of the island and very high up is Menaud Pond, a splendid body of pure fresh water, capable of furnishing an ample supply to the new institutions. There is no perceptible inlet or outlet; the supply seems to be derived from springs, such as may be conceived to originate upon the mainland, to pass beneath the bay and to rise to the surface at the summit of Nashawena. Except for the accidental presence of land here this stream would have risen to the surface in the midst of salt water. People familiar with the shallows over the region between Long Island and the Great Banks of Newfoundland speak of an 'underground river' extending from Labrador to Block Island having many outlets similar to the supposed one at Menaud Pond. Our theory of a connection with the mainland through Tertiary strata is a better one.

Conclusions.

The foregoing facts warrant us in believing in the existence of fresh-water springs bubbling up through the brine of the ocean. They are known to exist among the Hawaiian and West India islands and off the coast of Florida. The necessary conditions seem to be those which will permit the existence of underground streams flowing towards the sea; such as will render the boring of artesian wells successful. Evidently there must be strata—whether of the later fossiliferous rocks or igneous sheets—dipping gently seawards; and the springs can not appear very far away from the coast. We should, therefore, look for these phenomena adjacent to islands and all coasts bordered by Tertiary and basaltic rocks. They may be seen off nearly the entire eastern coast of the United States—from Cape Cod to the Rio Grande. Possibly also fresh water may be able to accumulate beneath the submarine belt of Tertiary between Nantucket and the Great Banks of Newfoundland. It is conceivable that they might be utilized for the supply of steamships in places where the local supply is either defective or unwholesome.

ECONOMY IN IRRIGATION.

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THE annual reports of the Reclamation Service of the United States and current numbers of *Forestry and Irrigation* embody, as is well known, a large amount of information of great general interest and at the same time of vital concern to that half of the country lying west of the Missouri River. What chiefly impresses the casual reader is the fact that a body of trained engineers, under government employ, in Arizona, California, Colorado, North and South Dakota, Idaho, Kansas, Montana, Nevada, Oklahoma, Oregon, Utah, Washington and Wyoming, are engaged in the great work of opening arid America to cultivation, and that irrigation is the chief agency by which this is being accomplished. Topographic parties are engaged in mapping and in sinking test pits, careful surveys have been made, land and water relations in different states have been thoroughly studied, and methods of raising, storing and distributing water are being worked out, both theoretically and practically, on a scale and in a manner new to the world. With a sympathetic popular interest awakened, the favorable attitude of the general government, and the high character and attainments of the experts who are engaged in solving the problems involved, the Reclamation Service has made noteworthy progress in a work that for scientific interest combined with economic importance is perhaps second to none ever attempted by any government.

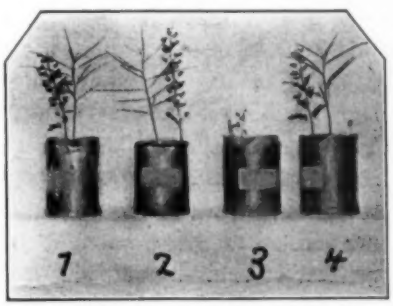
As is natural in a region where water is the one great essential, and of which it would seem that there can never be enough, the first thought apparently in all cases has been directed towards securing a sufficient and permanent supply, while economy of use has not, thus far, been embodied in any satisfactory general system. Years ago Professor Hilgard, of the California Agricultural Experiment Station, urged the necessity of more perfect utilization of irrigation water by putting it where it would do the most good, close to the stem of the plant or trunk of the tree, and letting it soak downward so as to form a moist path for the roots to follow to the greatest possible depth.* More recently Dr. Elwood Mead, chief of irrigation and drainage investigations, U. S. Department of Agriculture, has given measurements showing the great loss by seepage and evaporation from irrigation canals, and has discussed methods by which the water-supply might be more economically utilized. After giving tables which show in a striking manner

* California Expt. Sta. Bul. 121. 1898.

the extent of losses by methods still in vogue, the author concludes: "A comparison of the duties secured . . . leads to the belief that it will be possible through improved methods to double the average duty now obtained, so that the quantity now required for one acre will serve to irrigate two. If this can be accomplished it will relieve the scarcity under many canals, put an end to many controversies growing out of such scarcity, lessen the expense per acre for water and immensely increase the productive and taxable resources of the arid states."*

In various parts of the old world, where much valuable land has been reclaimed by irrigation, water is distributed in such a way as to secure the best practicable results. At Biskra, Algeria, for example, where the famous Deglet Noor date is grown and the supply of water is limited, an excavation is made around the base of each tree, and this is filled with water, thus greatly lessening the loss that would otherwise result from evaporation.† At Bassorah, on the river separating Persia from Arabia, the extensive date plantations are watered by means of a system of canals which are flooded with each high tide, dams of mud being built with the hollow trunks of palms run through them, which permit the water forced into the canals by the rising tide to flow away slowly. Thus, by taking advantage of favorable natural conditions, an ideal system of combined irrigation and drainage is effected at a minimum of expense.‡

In close agreement with the estimates of Dr. Mead, observations of the writer have shown that plants supplied with water below the surface of the ground have made a vigorous growth on a little more than one half the quantity of water that would be required if applied at the surface. To report a single rather striking case—the plants shown in the accompanying figure are photographs of seedlings of palo verde (*Parkinsonia,* two species) which, with some other desert plants, were under investigation. They are here shown as they appeared August 10, after being supplied with measured quantities of water since June 12. During this period numbers 1 and 2 each received 71 ounces of water, while numbers 3 and 4 each received but 39 ounces, or 55 per cent. as much as 1 and 2. Numbers 1 and 3



SEEDLINGS OF PALO VERDE. Number 3 had as much water as number 4, but it was not economically applied.

* U. S. Dept. Agr. Office of Expt. Stations, Bul. 86. 1900.

† Swingle, W. T., 'The Date Palm and its Utilization in the Southwestern States,' U. S. Dept. Agr. Bureau of Plant Industry, Bul. 53. 1904.

‡ Fairchild, D. G., 'Persian Gulf Dates and their Introduction into the United States,' U. S. Dept. Agr. Bureau of Plant Industry, Bul. 54. 1903.

received at the surface all the water given them, while 2 and 4 were subirrigated by means of a three-fourth-inch glass tube which extended some three inches vertically into the soil.

These plants started all alike, and in every other respect except water-supply had an even chance, so that the difference in their development, as seen two months after the seeds were sown, is highly instructive. The thing which at once strikes the eye is the hopeless condition of the plants numbered 3, which, having had a meager supply of water, applied wholly at surface, had been left behind in the race at an early day and were now drying up. The plants numbered 4 had received exactly the same amount of water, but it was placed, by the simple method of subirrigation already described, where it would be utilized with a minimum loss by evaporation.

A comparison of numbers 1 and 2 indicates that there is no virtue in subirrigation, in itself considered. It is merely a means of preventing waste. Both of these had received a large quantity of water, the former at the surface, and the latter by way of subirrigation. As far as this experiment goes, then, it appears that aside from alkaline or other conditions requiring special treatment, which it is not the purpose of this article to discuss, water may be applied indifferently at or below the surface, if there is only enough of it. It is simply a matter of supplying the roots of the plant with all the water it requires. But if it only needs about half as much when applied in the simple way that has been described, the fact is of sufficient importance to engage the attention of horticulturists from Colorado to California. It is true that reports on the results of subirrigation, thus far, have not been encouraging in all respects, and the application of such methods on a large scale would necessarily involve a rather large initial outlay; but when one considers the great expense involved in preparing for the irrigation of an orange grove, say, in southern California, and the continual outlay of time, labor and money required by the present wasteful methods of applying water, it may well be asked whether some simple method of subirrigation may not be developed which, when once the practical difficulties have been overcome, will prove in the end more economical as regards cash outlay, and at the same time make it possible for the available water to do double duty.

It is to be borne in mind that with very few apparent exceptions, such, for example, as the areas bordering upon the lower Colorado, the arid states and territories are nowhere possessed of an unlimited water-supply; in most cases there is a fixed limit, beyond which no amount of 'development' will produce more water. If, then, by economical methods, a given quantity of water—all that can be depended upon for a certain area—can be made to irrigate satisfactorily twice as many acres as by wasteful methods, he who shows how this can best be done, and inaugurates the doing of it, will deserve well of his country.

MINING AND USE OF METALS BY THE ANCIENT EGYPTIANS.*

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THE use of metals by the ancients antedates authentic history. So far as the discoveries of the archeologist have shown, the metals first used by mankind were those which occur native, such as gold, silver and copper. These three possess qualities which would appeal to the primitive workman. They are all bright and beautiful when polished, they are all malleable and easily shaped with the hammer, they respond readily to the graving tool and are highly resistant to fire. The ancient Egyptians knew, and used, gold, copper, silver, iron, lead and tin, and the alloys, bronze, brass, electron and solder. The fact that brass was used has led some Egyptologists to believe that zinc was known, but the unalloyed metal has not been found, nor do the inscriptions contain any reference to it. The majority of writers, therefore, hold that the brass was produced by mixing some ore of zinc, possibly calamine, with copper ores in the smelting furnace. The oxide of manganese is supposed to have been an article of commerce between the Bedouins of the Sinai peninsula and the ancient Egyptians.

'Nub,' the Egyptian word for gold, is found in the oldest inscriptions, and at Beni-Hassan, a series of pictures dating back to the twelfth dynasty, 2130–1930 B.C., illustrate the whole process of making gold ornaments. Centuries before this, the Nubians had mined gold in the mountainous, desert regions between the Nile and the Red Sea, and it has been suggested that the name Nubia is derived from the name of the metal. The Egyptian kings of the twelfth dynasty invaded Nubia and finally annexed that part of the territory containing the gold mines, and built and garrisoned a wall which should mark the boundary between the two peoples. The mines were vigorously operated by the new owners, and the quantity of gold in the land of the

* The materials for this article have been drawn from many sources, and it would be impossible to give specific references, as a single sentence may contain facts taken from several writers. The principal works consulted are: Birch (ed.), 'Records of the Past'; Brugsch-Bey, 'Egypt under the Pharaohs'; Mahaffy, 'Empire of the Ptolemies'; Maspero-Sayce, 'Dawn of Civilization'; Rawlinson, 'Ancient Egypt'; Perrot and Chipiez, 'History of Ancient Egyptian Art'; Winckler, 'The Tell-el-Amarna Letters'; Adams, 'Egypt Past and Present'; Von Meyer, 'History of Chemistry'; Erman, 'Life in Ancient Egypt'; Chas. J. Alford, *Eng. and Min. Jour.*, Vol. 73; Professor Petrie in *Harper's* for July, 1888.

Pharaohs increased rapidly. At the opening of the New Empire, about 1530 B.C., the lavish use of this metal by the kings indicates the wonderful productiveness of the mines. Much gold is believed to have been brought into Egypt from Ethiopia and the eastern shores of the Red Sea, and gold dust (?) from the Soudan.

Within the last few years the ancient workings of many gold mines have been discovered in eastern and southern Egypt and in Nubia. The mining region of Egypt proper was the mountainous belt bordering the Red Sea from the Gulf of Suez to the southern part of the country, where it connected with the mining area of the Nubian Desert farther inland, and with that of Nubia proper. Charles J. Alford* describes the northern part of this region as follows: "The larger mountain masses are usually formed of a hornblendic granite. Surrounding these, in lower ranges, and covering very extensive areas, is a rather fine-grained gray granite, passing in places into a gneiss, and that into mica schist, traversed by dikes and intrusions of greenstone, felsite, porphyry, and a very fine grained, white, elvan granite. It is in these rocks that most of the auriferous quartz veins were found to occur, and the more the granite was cut up by the instrusive rocks, the more frequent and more promising the quartz veins appeared to be."

In this region a number of mining sites were found which consisted of groups of round and square huts built of rough stone. Some of these villages are surrounded by walls. The old sand-filled workings follow the veins and ore-shoots, but with few exceptions the working faces and the bottoms of the shafts have not been uncovered by recent explorations. Near Um Rus on the Red Sea, there is an ancient camp of large size. A large number of quartz veins outcrop in a gray granite which is much cut by dikes of greenstone, porphyry and felsite. Nearly all the veins were worked in ancient times, and in places some of the rich ore-shoots have been completely worked out, while the leaner ore has been allowed to remain. The veins vary in thickness from one to over three feet, and all carry free-milling gold in varying amounts. The quartz is white to gray in color, and in places carries a little pyrite. The ore seems to have been reduced to a coarse powder by means of stone rolling pins on elliptical rubbing stones. It was then transferred to a circular mill consisting of an upper and a lower stone.†

At one of the camps in the south, there is the ruin of a building 260 feet by 190 feet, which is supposed by some to have been the mill in which the gold was separated from the ore. At the old workings near Coptos, Lat. 26° N., may be seen the ruins of over 1,300 stone huts once occupied by the miners. Very extensive workings found still farther to the south are probably the mines for which the kings of the twelfth dynasty sacrificed the lives of many thousand men, and

* *Eng. and Min. Jour.*, Vol. 73, p. 103.

† See illustration, *Eng. and Min. Jour.*, Vol. 73, p. 104.

from which the largest supply of Egyptian gold was derived. They are located in an almost inaccessible mountain group surrounded on all sides by a waterless desert. Here may be seen tunnels and shafts penetrating the mountains to unknown depths. Three hundred stone huts shelter three hundred mills used in pulverizing the ore, immense cisterns once caught the scanty water supply from the higher slopes, and near them stand the sloping stone tables on which the pulverized ore was washed. Records show that these mines were worked with but little interruption for twenty centuries by the Egyptians, and we have no means of knowing how long they were worked by the Nubians before them.

Inscriptions near the mines recount the difficulties of the journey by which the region was reached, and, judging by the loss of life on the way and the distress suffered by those who reached the goal, the 'Forty-niner' and the Klondiker could not tell of greater hardships. The miners were largely prisoners of war and criminals. The Greek writer, Diodorus (III. 11.), describes the operation of the mines in the time of the Ptolemies, and the terrible sufferings of the laborers under their brutal taskmasters.

The oldest charts or maps of any kind in existence are two papyri showing the topography of the country, and the position of the workings, mills, miners' houses and other buildings connected with some of these ancient mines. One of these maps was made in the reign of Ramses II., the second king of the nineteenth dynasty, which began about 1320 B.C. The locality mapped is in the Bechen Mountain, east of Coptos. The other, better preserved, but having lost the name, shows the position of four short ranges or rows of mountains with the valleys between them; the position of the mines, high on the slopes of one of the peaks; the workmen's houses; the water-tanks, the place where the gold washing was done, the areas of cultivated ground; a temple site and other details. Some of the mountains are colored red, and across them are written the words: 'These are the mountains where the gold is washed; they are also of this red color.' Von Meyer* says that in the time of Ramses II. the Nubian mines yielded $625,000,000 worth of gold annually. (The world's production of gold for 1903 was valued at approximately $327,000,000.) The kings of the eighteenth dynasty also received gold in considerable quantity from the Soudan and from the eastern shores of the Red Sea.

In all the Egyptian and Nubian mines the ore was in the form of native gold in a quartz gangue. Some of the veins are of large size and are considerably branched. The vein matter was fractured and loosened by building fires over it. The blocks were then dug out by the miners, possibly with iron tools; and old men, women and children carried the ore to the crushers. The earliest form of mill

* 'History of Chemistry.'

consisted of a small stone mortar with a stone pestle. But there was a development in milling methods, and the next consisted of a block of rock, with a slight depression in the top for the ore, which was pulverized by means of a heavy rubbing stone. A still later development, possibly belonging to the time of the Ptolemies, 330–322 B.C., was a mill somewhat like the arastra which may still be seen in California and Mexico. It consisted of a block of rock several feet in diameter and circular in outline, in the top of which was a shallow depression to receive the ore. The pestle consisted of a large spherical or cylindrical block of the same kind of rock. The finely broken ore was placed in the depression, and the movable block was rolled around over it until it was reduced to the desired fineness. The mill was essentially a huge shallow stone mortar in which the pestle was rolled by slaves.

The powdered ore from the mortars was sprinkled upon the tops of sloping stone tables over which water was kept running. By this means the lighter rock powder was carried away and the gold remained behind. The supply of water was secured by the construction of large cisterns or reservoirs on the slopes of the mountain. In the upper ends of the tables there were tanks for the immediate supply, and the operator dipped the water out and poured it over the sloping surface. When a quantity of gold had accumulated on the table it was removed, dried and placed in a covered clay crucible and heated for five days in a charcoal fire blown constantly by a rude bellows, or by mouth blowpipes. No fluxes were used in the earliest times, but it was not long before these primitive metallurgists learnt the use of lead and common desert salts in refining their gold. Diodorus Siculus—second century B.C.—mentions the use of lead by the Egyptians in the refining of gold, but it is believed that it had been in use many centuries before his time.

Pictures and sculptures of very early date show the refiners of gold (and silver) sitting before the fire with blowpipes of very large size, but otherwise not unlike those in use at the present time. The main part of the pipe was probably of wood, but a metal tip concentrated and directed the current of air. Others show the workman blowing the fire with a bellows consisting of two leather bags furnished with metal nozzles. The bellows was distended by pulling a cord attached to the upper side of the bag. When at work, the operator stood with one foot on each bag and held the cords in his hands. Then by a swaying movement he threw his weight first on one foot and then on the other and at the same time pulled the cord attached to the bag from which the pressure was removed, raising its upper wall and causing it to take in air and become distended. The pressure of the foot forced the air through the nozzle of the bellows into the fire. When a large amount of metal was to be worked, an open fire of charcoal was used and a

bellows was placed on each side. For smaller amounts, the fire was placed in an earthen bowl and the blowpipe was used to fan the flame.

Goldsmiths. The goldsmith was held in higher esteem than any other craftsman. This regard was probably due, in part, to the fact that he prepared the images of the gods, the finer decorations for the temples, and the jewels and vessels for the royal household. The guild was under the direct control of the king, and was thoroughly organized by his command into goldsmiths, chief goldsmiths and superintendents of goldsmiths. The trade passed from father to son in a sort of family trade union. Plato says that in Egypt every particular trade and manufacture was carried on by its own craftsmen, and none changed from one trade to another or carried on several. As early as the twelfth dynasty, 2130 B.C., the Egyptian goldsmiths had attained a high degree of skill in their work; and the wonderful jewels found on the mummy of queen A'hhotep and in the tomb of Kha-em-uas, son of Ramses II., for elegance of design, delicate engraving and beautiful inlaying are not excelled at the present time. That some of this work could have been done without the aid of a lens, is considered impossible. A type of cloisonne work, the outlining of figures and the tracing of designs in delicate gold and silver wire to be filled in with precious stones or other metal, was a remarkable feature of the goldsmith's art. (The Chinese cloisonne work differs in that the filling is largely with enamel and porcelain, and is hardened in place by burning.) Gold plating was practised in very early times, and some of this work manifests a skill not to be scorned by the best workers of the twentieth century. The gold leaf was undoubtedly made with the hammer, and its uniform thickness speaks well for the skill of the goldsmith. Inlaid work with settings of precious stones and enamels was common. Gold was extensively used to overlay models in wood and other material in sculpture and architecture.

The tools used were of the simplest kind, probably including only the blowpipe, tongs, forceps, hammer and graving tools. A very large part of the work was done by softening the gold in the fire and pressing it into shape with forceps and tongs. The casting of gold was much practised in the latter part of the Middle Empire, about 1600 B.C.

In the inscriptions of the New Empire, various kinds or grades of gold are mentioned, as: 'mountain gold,' 'good gold,' 'gold of twice' (refining?), 'gold of thrice,' 'gold of the weight,' 'good gold of Katm, that is, of the Semitic countries. The 'gold-brick' and the tenderfoot are not peculiar to the present day. In one of the Tell-el-Amarna letters, written during the eighteenth dynasty, 1600–1400 B.C., the king of Babylon accuses Amenophis III. (or IV.) of Egypt of sending him a mass of base metal for gold. He says: 'The twenty minas of gold (you sent me) contained, when melted down, only five minas of pure gold.' In a letter from Mitani to the same monarch, the writer says:

'The gold you sent was very little and alloyed,' and in a later letter he says: 'A testing of a delivery of gold, undertaken before the whole royal court, has revealed the fact that what was sent was not gold at all.'

The chief uses of the metal among the ancient Egyptians were for ornament and decoration, and, to a limited extent, as a measure of value, but this use was probably not common except when very large sums had to be paid over. For use as money, it was fashioned into broad, centrally perforated discs or rings about five inches in diameter, but of one standard thickness or weight, and all payments necessitated the use of the balance. Among the commoner articles made of gold were articles of personal adornment—diadems, necklaces, armlets, bracelets, finger rings, earrings and various kinds of jewels. Domestic utensils, except those for the royal household, were seldom made of gold. Vases and other decorative vessels, images of the deities, statuettes of the kings and other royal personages, and images of the sacred animals were commonly made of hammered or cast gold. It was extensively used for temple and altar decorations, particularly during the New Empire, after the conquest of Nubia and Syria in the eighteenth dynasty. The Syrian goldsmiths were superior craftsmen, and much of their work found its way into the temples of Egypt. The decoration of the temples was an act of the most worthy piety, and it was the duty of the king's convoyers of gold from the mines to make an offering of gold in the temples.

When wrought into jewels and chains, it was used by the ruler as a means of bestowing rank and favor upon his worthy officials and court favorites. A victorious general was called into the king's presence, and 'before all the people, in the sight of the whole country,' the 'decoration of the gold' was conferred. The king commanded the royal treasurer to place about the neck and body of the honored servant a certain number of gold chains, and to present him with jewels and gifts, frequently of symbolic character. These might be in the form of bees, lions, bracelets, necklets, hatchets, vessels for ointment and ornament, all worked from the finest gold. The persons receiving this honor were afterwards known as 'the creatures of the gold.'

There is good reason to believe that the Egyptians used unalloyed copper in their arts and manufactures for centuries before they discovered that the addition of a little tin would greatly increase its hardness, make it more responsive to heat, and greatly widen its field of usefulness. But within the period covered by authentic history, copper alone seems to have had a much more limited use than bronze, and the archeologist finds that objects made of copper are not very numerous among the relics of any period of Egyptian history. It is held by some that the name used in the inscriptions for bronze sometimes refers to copper.

Possibly on account of the great abundance and long use of copper, very little definite information has been preserved regarding the process of extracting it from its ores, the making of the alloys (bronze and brass) or the methods of manufacturing copper and bronze objects. The goldsmith has received a great deal of attention from the sculptor and the painter, but the more practical and more indispensable worker in bronze has been almost wholly neglected. It is said that the only known picture illustrating the working of bronze is that of a man making knives. Even in the copper mines, the inscriptions rarely refer to copper as a product. Malachite, regarded by the Egyptians as one of the choicest of precious stones, and turquoise are spoken of as though they were the objects sought.

There was very little copper mined in Egypt, though it is said that native copper was found there (von Meyer). The great source of the metal was the Sinai peninsula. While most of these deposits were exhausted in ancient times, one at Wadi Nasb has been worked in recent years. To supplement the supply from these mines copper was imported. In one of the Tell-el-Amarna letters, written by the ruler of Cyprus to Amenophis III. (or IV.) in the fifteenth century B.C., the writer says: "I can only send this time 500 talents (?) of copper, for the plague prevails in my country, and for this reason no despatch of silver could take place." In another letter he says: "I am sending you 100 talents of copper."

When the Egyptians wanted gold they invaded Nubia and took possession of the mines. When they wanted copper they drove back the nomadic tribes of Sinai and built fortresses to defend themselves while they secured the metal which played such an important part in their national life. The most important mines were those of Wadi Maghara which had been worked by the natives, and from which they are said to have brought oxides of copper to the Nile delta. It is probable that the Egyptians made several unsuccessful attempts to get possession of the mines at a very early date. But it was not until the time of Zosiri, possibly in the third dynasty, that they succeeded temporarily in holding the region. Whether the conquerors followed up their victory and worked the mines in uncertain, but it is known that they were vigorously operated by King Snofru of the fourth dynasty, not later than 2830 B.C., and according to several authorities, much earlier. Other mines opened later, were the Wadi Nasb, the Sarbut elchadim and mount 'At'eka. Of these, the Sarbut elchadim were opened by Amen-eh-hat II., of the twelfth dynasty, about 2130–1930 B.C. All these mines, except those of 'At'eka, are in the mountains on the west side of the peninsula. The exact position of the 'At'eka mines is not known, but they were near the Gulf of Akaba on the east side of the peninsula, and so situated that the product was brought to Egypt both by sea and by land. They were opened by Ramses III., the second king

of the twentieth dynasty, which, according to Erman, lasted from 1180–1050 B.C. The western Sinai copper and turquoise mining region is separated from the Suez Gulf by a narrow plain and one range of hills. Pharaoh's men called it the country of grottoes, in allusion to the many pits and tunnels made by the Bedouin miners who preceded them. It is known that in very early times copper ore of some kind was mined not far from the gold mines of the southern desert region, but the workings indicate that no great amount of metal was produced from this locality.

The country rock of the west side of the peninsula is a soft, friable, yellow sandstone, probably cut by porphyry dikes,* and the method of laying out the mines was not unlike that used in coal mining at the present time. Tunnels or entries were driven and rooms were worked out on each side, leaving pillars of rock to support the roof.

On a peak at the junction of the Wadi Genneh and the Wadi Maghara, the traveler finds a low wall enclosing a group of over 200 stone huts—some round and some rectangular—in which the miners of many generations lived. With the exception of the houses of the overseers, which have two rooms, the dwellings consist of a single room, on one side of which a stone bunk or bench may have served for table and bed. The walls of the houses are made of the sandstone from the mines, and are laid up without mortar. The door is a very narrow opening in one of the walls. The roofs were made of wicker work covered with clay. The village was garrisoned to protect the miners from the native tribes, and a temple was erected for the worship of 'Hathor, the lady of the malachite country.' Below the village, an artificial lake or reservoir was formed by damming the valley, and the shellfish of the lake were used as food, along with dates, oil, milk and a coarse bread, with occasionally a fowl or some other meat. Occasionally the king sent a supply train into the camp, and an inscription says that one of these consisted of: corn, 16 oxen, 30 geese, fresh vegetables, live poultry and other things.

The tools found in the village were all of flint, and included knives, scrapers, hammers, saws, arrow heads and spear points. Stone tools with wooden handles were found in the mines, but it is probable that these were used in making the inscriptions which cover the walls, and that the mining was done with bronze tools. The mine laborers were principally criminals and prisoners of war, but an inscription records the fact that one of the kings sent out an army officer and 734 soldiers to work the mines. There seems to have been but little interruption in the operation of the mines from the latter part of the third dynasty until the end of the sixth (from about 2830 to possibly 2400 B.C.). From this time until the twelfth dynasty (2130 B.C.) but little work was done, but in this dynasty Egypt was on the crest of one of

* See Dana, under 'Turquoise.'

those great waves of prosperity which marked the nation's history. These and other mines were worked with great energy, and the national coffers were filled. The goldsmiths and bronze workers of this time have left behind them some of the most elaborate and beautiful specimens of their art. From the twelfth until the twentieth dynasty there were periods of great mining activity separated by others in which but little was done. The eighteenth dynasty (1530 to 1320) was a period of great mineral production, but during the twentieth (1180–1050 B.C., Erman, or 1280–1100 B.C., Rawlinson) most of the mines were almost exhausted. Major Macdonald, a Scotchman, built a house just below the village and worked one of the mines for turquoise some time within the nineteenth century. Monuments still stand at the Sarbut mines, recording the names of a long list of mine managers appointed by the various Pharaohs. When large quantities of copper or turquoise were wanted, the king would send out 1,000 or 2,000 additional miners, metallurgists and laborers to expedite matters.

The inscriptions show that the strike is not a new institution. A company of Egyptian prospectors used this means of bringing the managers to terms. The method employed by the manager to get his men to continue work is one which has not been tried in America. The men were called together to discuss matters, and they agreed to work if the manager would insure them the favor and protection of Hathor, the goddess of the region. The terms were complied with, and the men went to work.

The ruins of ancient refining works are found near the west Sinai mines, but from the very meager description found it is impossible to get any idea of the method of treating the ores. The fuel used was charcoal and wood. The ores mentioned in connection with these mines include malachite, the oxides of copper, native copper and a blue precious stone, which may refer to turquoise or to azurite. As the malachite was considered a precious stone, only the inferior part of this mineral would be used as ore. Whichever one of these ores predominated, the metallurgical process would be a rather simple one, but the copper produced was of a high degree of purity. The following quotation from Brugsch-Bey makes it clear that the ore of 'At'eka was smelted at the mines: "The metal shining like gold and in the form of bricks, was brought from the smelting-houses in those parts and laden on ships."

At certain periods in Egyptian history, as, for example, early in the new Empire (2130 B.C.), copper seems to have been recognized as the standard of value, and accounts were reckoned in uten of copper. These coins, if such they may be called, were made of very exact weight (about 91 grams), and were in the form of a spiral. Some of the blue and green pigments used by the artists and painters contain copper salts.

Bronze, the alloy of copper and tin was the Egyptian's tool-steel, his cast and wrought iron—in short, all that iron and steel are to the American. Just when he discovered the effect of tin on copper there is no means of knowing, but certain it is that many centuries have passed since he came into the possession of the secret.

The presence of flint tools only, in the deserted mining camp in Wadi Maghara can not be used as an argument that bronze and iron tools were not then in use, for they are mentioned in inscriptions, pictured in paintings and sculptures and are found in tombs belonging to a period many centuries before the abandonment of the mines. In the time of Herodotus the Egyptians used both stone and metal cutting instruments. The use of bronze is mentioned in inscriptions antedating the Great Pyramids. Of the work of the first three dynasties, Rawlinson says: 'A metallurgy of no small merit must have formed and hardened the implements whereby materials such as those employed by the Egyptian builders and sculptors were worked with ease and freedom.'

Possibly the oldest piece of cast bronze whose age has been established is a knob from the scepter of Papi, a Pharaoh of the sixth dynasty (about 2500 B.C.). This and other bronzes of very great antiquity are in the British Museum. The Posno collection in the Louvre contains two statues which are believed by Perrot and Chapiez to date from the close of the Old Empire or the beginning of the Middle Empire (about 2300–2000 B.C.), but Erman says they are 'archaistic works of the twenty-sixth dynasty (about 650–525 B.C.). They are light, hollow and cast in one piece. The eyes and eyebrows were made of precious stones inlaid in the bronze. The technical skill and workmanship displayed are said to be extraordinary. A hollow cast statue of Ramses II., of excellent design and skilful workmanship, dates from about 1300 B.C.

In the inscriptions, several kinds of bronze are spoken of again and again, as, for example, 'bronze,' 'bronze in the combination of six' and 'black bronze.' These varieties contain the constituent metals in different proportions. A very common bronze, used for a variety of purposes, contains copper 85 per cent., tin 15 per cent.; another common bronze has the composition: copper 88 per cent., tin 12 per cent. A bronze used for weapons and cutting instruments is found by analysis to contain copper 94 per cent., tin 5.9 per cent. and iron .1 per cent. Without the iron, this would be the softest of the three, but the iron probably compensates for the lower percentage of tin. It is evident that the use to which the alloy was to be put determined the proportion in which the metals should be combined. This fact supports the belief that from very early times the metal workers used metallic tin in the manufacture of bronze, and, therefore, that they were familiar with the separation of tin from its ores. Bronze weapons of the composition mentioned above, were so skilfully tempered that, after the lapse of

many centuries, their elasticity is almost equal to that of the best steel.

The working of bronze was one of the more honorable branches of industry, and must have furnished labor for a large number of men. Of the various subdivisions of this industry, that of the armorer was held in highest esteem. Reference has already been made to the lack of data concerning the metallurgy of copper and of bronze. But the finished products show that furnaces and smelting pots of large size must have been used in preparing the molten alloy for the molds. The bronze work of different periods shows varying degrees of skill, and it is difficult to say at what time the bronze workers attained the greatest excellence in their art. Both cast and hammered bronze work is found, which in grace of outline and perfection of finish has rarely, if ever been surpassed. The more elaborately finished work includes chasing, inlaying with precious stones, gold and silver, designs in gold and silver wire inlaid with other bronzes, enamels and precious stones. The method of inlaying with gold and silver consisted in making a groove in the bronze, laying the gold on and hammering it into place.

It would be almost impossible to enumerate the uses to which bronze was put. Some of the more important are: weapons and armor; farm implements (in part), artisans' tools, household utensils; boat and chariot building; architectural hardware, such as nails, bolts, hinges, locks; statuary, images, decorative objects and articles for personal adornment.

Iron. Iron never found wide favor in ancient Egypt, but there are abundant evidences that it was used side by side with bronze for tools of various kinds. There is no reason to believe that it was ever commonly used for decorative purposes, either in architecture or otherwise. The finding of iron bracelets proves that it was occasionally used for personal adornment. Even its use for tools seems to have been much more limited than that of bronze.

It has been suggested that the scarcity of iron objects may be accounted for, in part at least, by the readiness with which iron is destroyed by oxidation, especially in a soil so rich in niters as that of Egypt. It is also significant that the Asiatic neighbors of the Egyptians—the Hebrews, the Canaanites, the Chaldeans, the Babylonians and other contemporaneous peoples were familiar with the uses of iron.

Lepsius believes that this metal was used in Egypt as early as 3000 B.C., that it served primarily for hard instruments, and was prepared in smelting furnaces. The Great Pyramid was built by Khufu (Cheops), of the fourth dynasty, and not later than 2800 B.C. Herodotus says that iron tools were used in the construction of the great Pyramids, though others find reason to believe that the tools used were of tempered bronze. The question is of little importance in view of the fact that a band of iron was found in an inner joint of the Pyramid of Cheops, where the ancient architect placed it.

Thebes and Memphis are so ancient that history has preserved no record of their founding. Yet in the tombs of these long-decayed cities are found tools and other articles of iron, some of which may be seen among the treasures of the New York Historical Society. An ancient inscription at Harnak tells us that Thothmes I., who reigned in the eighteenth dynasty (probably 1500 B.C.), received from his chiefs and vassal kings, 'bars of wrought metal and vessels of copper and of bronze and of iron,' and from near Memphis he received lead, iron, wine and wrought metal. Iron was so highly prized that it was considered a desirable article of plunder, and the soldiers of this same monarch, on their return from fighting Chadasha, brought 'iron of the mountains, 40 cubes.' An iron sickle was found beneath one of the sphynxes at Harnak, but it may have been placed there not more than 600 years B.C. When the great obelisk that now stands in Central Park, New York, was taken from its original position on the banks of the Nile, a piece of very pure iron was found beneath it. 'Pieces of iron tools have been found at various places, bedded in masonry of very ancient date' (E). In the twenty-fifth dynasty iron was used for the door frames of the temple of Ptah. Very few of the iron relics found are well enough preserved to show the character of the workmanship, but they do show that the art of tempering iron was known at a very early date.

The known sources of Egyptian iron include the desert region of the south between the Nile and the Red Sea, and the Sinai peninsula. At Hamami in the desert there are the workings of an ancient iron mine from which hematite was taken, but no evidences of smelting have been reported from this locality. The mines of the Sinai region must have been an important source of this metal as well as of copper. In 1873 ruins of extensive iron works of great antiquity, but of undoubted Egyptian origin, were discovered near the Wells of Moses, and it is possible that ancient Arabia learned the metallurgy of iron from the Egyptians. There is also reason to believe that iron was imported from Chaldea, Phoenicia, Babylonia and Assyria.

Of the metallurgical processes used in the treatment of iron ores little is known. Oxides or ochers of iron were used for the yellow, brown and red pigments so commonly used in Egyptian art. Some of the iron articles found are tools of various kinds, weapons, bracelets, keys, wire, door-frames, fish-hooks, etc.

The inscriptions make but few, if any, references to tin, and comparatively few articles made of that metal have been found. For these reasons, it is held by some writers that the ancient peoples, the Egyptians included, did not understand the separation of the metal from its ores. But the fact that plates of pure tin have been found in considerable number in the tombs is an answer to those who hold this view. These plates were shaped and used to cover the incision made in the

right side of the corpse to remove the viscera preparatory to embalming. They were engraved with the symbolic eye-emblem of the sun-god Shu. But the principal use of tin was in the manufacture of the two alloys, bronze and solder, of which the former was many times the more important. Solder, the alloy of lead and tin, was very much used in the metal-worker's craft. The sources from which the Egyptians drew their supply of tin are not known. It is believed by some that the Phoenicians brought it from Spain and later from the shores of Britain. It has also been suggested that it may have been brought from the East Indies by very indirect channels of trade. Whatever may have been the source of supply, tin was used in large quantities by the ancient Egyptians.

Silver. Silver and gold were the precious metals of Egypt. In very early times silver was the rarer and more precious. This is probably due to the fact that it was not produced in Egypt or the neighboring countries. In later times when commerce developed and the products of all the earth began to come to the ports of the Nile and the Red Sea the two metals changed places in respect to value. The greater rarity of silver in the earlier dynasties is shown by its very limited use, as well as by the fact that in the old inscriptions it always stands before gold. Gold was lavished on the mummies and on the tomb decorations of the wealthy, but silver was seldom used in this way. In the temple decorations silver played but a small part, and in the ceremonies by which rank and title were bestowed upon faithful officers and court favorites, silver is rarely mentioned. The gifts to the king rarely include it, though copper and bronze are generally mentioned.

But about the time of the eighteenth dynasty the Phoenicians and Syrians brought much silver from Cilicia, and the island of Cyprus sent this metal to Egypt, as is shown by the Tell-el-Amarna letters. From this time the use of silver is much more common for many purposes than that of gold. King Ramses III. records the fact that during his reign of thirty-one years he gave to the temples, among other gifts: 1,015 kg. of gold, 2,994 kg. of silver, 940 kg. of black bronze and 13,060 kg. of bronze. Its use, likewise, in the arts became much more common, both alone and in the alloy *usm* or electron.

In the nineteenth dynasty, Ramses II. and Khita-sir, king of the Hittites, made a treaty for mutual protection and support. A silver tablet has been found on which is engraved the whole text of the treaty, and it is almost as wordy as similar documents of the present day.

The work of the silversmith was similar to that of the goldsmith, and vases of the Middle Empire (2130–1530) show more than average elegance of design and delicacy of workmanship, but the very elaborate work often found on objects of gold is rarely seen on those of silver. It is a remarkable fact that gilded silver is found.

Objects made of silver include jewels and other articles of personal adornment, plates for the adornment of mummies; statuettes of the gods and figures of the sacred animals; vases, and rings used for money. The central treasury was known as 'the house of silver of the treasury,' but the reason for the name is not apparent, unless at some time silver formed the principal money of the nation.

Electron, Egyptian 'usm.' This was an alloy of silver, gold and usually copper in small amount. The proportions were about 150 silver, 100 gold and 5 copper. Though not beautiful, it ranked with the precious metals, and was used chiefly for personal adornment and for vases, but occasionally it found a place in the more costly temple decorations. In the restoration of the temple of Ptah, in the twenty-fifth dynasty, the doors were made of electron (*usm*). Von Meyer states that this alloy was regarded as an individual metal, and that probably no means of separating the two metals was known. Lepsius, on the other hand, thinks that it was made by combining the metals by weight in much the same way as copper and tin were used in making bronze. Erman* says that from the 'Great Harris Papyrus' it appears that in weighing *usm* 1,278 uten of gold, 1,891 uten of silver and 67 uten of copper were employed. It is probable that this alloy was not used until after the change in the relative values of silver and gold mentioned above.

Lead. Of the metals known to the Egyptians, lead seems to have been the least used. Very few, if any, leaden objects have been found, and the only ways in which the metal is known to have been used are in the making of solder and in glazing pottery. The white pigment used on the mummy wrappings has been spoken of as white lead, but other writers state positively that no white lead has been found on the mummies or about the tombs. In very early times lead was mined in the desert region not far from the gold mines, and inscriptions state that it was received as tribute from foreign peoples.

* Foot-note, p. 461.

ANAXIMANDER, EARLIEST PRECURSOR OF DARWIN.

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AS has been aptly remarked by Huxley, 'There is no snare in which the feet of a modern student of ancient lore are more easily entangled, than that which is spread by the similarity of the language of antiquity to modern modes of expression.' The great exponent of evolution observes further in the same connection that he does 'not pretend to interpret the obscurist of Greek philosophers'; all that he wishes to point out is that 'the words, in the sense accepted by competent interpreters, fit modern ideas singularly well.'*

The force of these remarks becomes manifest when one inquires into the rightfulness of regarding Anaximander, the Milesian, companion or pupil of Thales ('*sodalis Thaletis,*' Cicero calls him) in the sixth century before our era, as the first who foreshadowed modern ideas of evolution. It may be of some profit for us to consider briefly the manner in which his doctrines have been interpreted by naturalists, and thereafter to examine into the original sources, which have preserved for us the skeleton of his system, and can alone enlighten us in regard to his conception of nature. An inquiry of this kind will not be without value in case it merely serves to bring home and emphasize the fact of historical continuity of ideas which are commonly considered as modern.

It is a matter of no little moment, when we stop to realize it, that conceptions of organic evolution, and also of a heliocentric cosmogony, assumed shape in the mind of man, however vaguely or imperfectly, in periods of remote antiquity, and have exercised a determining influence on human thought ever since. Natural laws become invested with new and more profound interest on finding that they have seldom been discovered offhand, revealed, as it were, by a single flash of genius; but by the progressive development of ideas, extending sometimes throughout centuries, and leading from dim, far-distant adumbrations up to our present understanding of the truth. There comes to us, also, through the tracing of ideas back to their sources, an increased sense of our indebtedness to the princely legacy of Greek thought. It has been justly said by one of Huxley's distinguished pupils, that 'even amidst our present wealth of facts, the impassable boundaries of human thought seem to confine us to unconscious revivals of Greek con-

* Huxley, T. H., 'Evolution and Ethics,' in his 'Collected Essays,' Vol. IX., p. 69 (London, 1894).

ceptions. There are many observers, but few who can strike out into the absolutely virgin soil of novel suggestion.'*

Early christian theology reveals very clearly the impress of Greek philosophy, and natural science may be said to have been dominated by it. In so far as the theory of evolution is concerned, history shows beyond all doubt that it took its rise among Ionian philosophers, declined with the decay of Greek science, was kept alive by Greek influence in theology, and, after gathering increased momentum, became revealed in fuller grandeur to Lamarck and Darwin. Yet scholars are by no means agreed concerning the extent to which either the central theory, or its subordinate propositions, such as the law of the survival of the fittest, were developed amongst the Greeks. Many important scientific discoveries were actually anticipated by this ingenious people, though they seem to have felt their way rather by intuition than by inductive reasoning combined with the observational method. It is the belief of conservative writers that the Greeks anticipated the evolution idea by suggestion, or by a series of happy conjectures, though indeed they carried it well into the suggestive stage; nor does it seem possible to maintain a more superlative estimate than this.

The question as to who was the first evolutionist has been answered in various ways.† Professor Osborn, in the work above quoted, holds to the belief that it is not Anaximander, but Empedocles of Agrigentum, who 'may justly be called the father of the evolution idea.' Huxley pays a general tribute to the sages of Miletus by calling them 'pronounced evolutionists'; but it is Heraclitus, the corypheus of the Physicists, of whom he avers that 'no better expressions of the essence of the modern doctrine of Evolution can be found than are presented by some of his pithy aphorisms and metaphors.' Haeckel, on the other hand, apostrophizes Anaximander as 'the prophet of Kant and Laplace in cosmogony, and of Lamarck and Darwin in biology.' Another distinguished German critic, Schleiermacher, venerates Anaximander as 'the father of speculative natural science'; and a not unlike sentiment has been voiced by Lyell.

The causes of this singular lack of unanimity are not difficult to trace; they have one and all to do with the original sources. In the first place we must note the different interpretations of the meager yet priceless materials that have come down to us, all derived in the last resort from the 'Opinions' of Theophrastus, a work long since obliterated by the hand of time. Secondly, we must pay due heed to

* Osborn, H. F., 'From the Greeks to Darwin,' p. 10 (New York, 1894).

‡ Out of a mythical and legendary past far antedating the Homeric poems, if we would believe certain French writers, it is possible to reconstruct the earliest archetype of Darwin. Those who, as the author of 'Modern Mythology' would say, 'care to go in for these things a little,' will do well to consult the following: Houssey, F., 'Nouvelles recherches sur la faune et la flore des vases peints de l'époque mycénienne.' *Revue Archéol.*, Vol. XXX. (1897), p. 81 ff.—Coupin, H., 'Le poulpe ea la croix gammée.' *La Nature*, May 20, 1905, p. 396.

the pitfalls Huxley has warned us against in the opening words of this article. Whoever seeks to understand ancient systems of philosophy must not be misled by 'the similarity of the language of antiquity to modern ideas of expression,' into supposing that the world presented itself to the classic mind under the same aspects, and that problems of nature and of life possessed for it the same significance, as in our day. Our contemplation of the universe has become modified by the sum-total of all the new ideas that have entered into the world during the last two thousand years, and if mental processes have not grown in the meantime more subtle, they have at least a vastly more complex *organum* to work upon. Speculations during the olden time were cast in a different psychic mold than with us; conceptions rested upon a different basis of fact; even the simplest words were used in a different significance. As M. Brochard sagely observes: 'C'est une erreur manifeste que de vouloir retrouver à tout prix chez les anciens nos propres solutions; mais c'est une aussi, est plus répandue encore, de s'imaginer que les questions à résoudre se posaient pour eux exactement comme pour nous.' What we understand now-a-days by the terms matter, motion, space, ether, soul and so on, is not what the corresponding words denoted in the past ages. Nomenclature, with halting gait, is invariably left behind by the onward march of ideas.

Disparity of modern estimates arises in still larger measure from another cause; from the attempted reconstruction of ancient systems of philosophy out of a handful of mutilated excerpts and traditions. Such attempts are almost certainly foredoomed, since the arbitrary nature of ideas precludes the application of a principle of 'correlation of parts,' by means of which the trained expert is enabled to restore missing features from a few characteristic fragments. Efficient as may be the workings of this principle in comparative anatomy, we must not be beguiled by the allurements of Renanism into transporting it, as some have endeavored to do, from the realm of morphological facts into the realm of ideas. We may be permitted to hazard shrewd guesses here and there, basing them upon the influence of *milieu* and previous suggestion, or upon contemporary analogy, in the endeavor to revive relics of intellectual progress that 'abode their little hour or two and went their way'; but beyond this we can not go.*

* For suggestions of contrary nature one may compare the following from Huit's 'Philosophie de la nature chez les anciens' (Paris, 1901): "Tel penseur de l'antiquité a eu son temps de célébrité: nous n'avons de son système qu'une connaissance rudimentaire et tronquée: à l'imagination et au raisonnement de le reconstruire. De l'œuvre antique rien ou presque rien n'a survécu; qu'à cela ne tienne: sur ces vagues indications, avec autant de hardiesse, mais moins de sûreté que Cuvier dans ses restitutions paléontologiques, l'esprit créera à nouveau ce qu'une autre pensée avait enfanté" (p. 208).

For an illustration of the manner in which suggestions of this nature have been carried out, we may refer to the attempted resuscitation of the doctrines of Empedocles by J. Bidez, the success of which is viewed by Professor Lortzing

Believing, as we think rightly, that Anaximander should be regarded as the earliest precursor of Darwin, it will be profitable for us at this point to examine the small collection of fragments which have survived, and which constitute the authentic sources of information in respect to his ideas of organic evolution. Notwithstanding these fragments are but five in number, they have not hitherto been searched out and brought together under one head in English form. Those desirous of consulting the original texts will find them collated in the indispensable works of Hermann Diels,* Ritter and Preller,† Fairbanks,‡ Mullach and others.

ORIGINAL SOURCES RELATING TO THE EVOLUTIONARY DOCTRINES OF ANAXIMANDER.

PSEUDO-PLUT. *Stromat.* 2 (Dox. 579).—Further he [Anaximander] declares that in the beginning man must have been born from animals of a different species. His reason is that, whereas other animals quickly find food for themselves, man alone requires long rearing. And it is evident that had he been originally such as he now is, he could never have survived. §

HIPPOLYT. *Philosoph.*, I., 6 (Dox. 660).—Primitive animals were derived from moisture evaporated by the sun. In the beginning man was of very different form than at present, and resembled a fish.

ÆTIUS *Plac.*, V., 19, 4 (Dox. 430).—Anaximander taught that the first animals were begotten in the water, and were covered with prickly integuments; on attaining sufficient age, they emerged upon the land, and, their coverings having burst, they soon changed their manner of life.

PLUT. *Symp.*, VIII., 8, 4 (Diels, *Fragm. d. Vor-Sokrat.*, p. 20).—Wherefore they (the Syrians) reverence the fish as of the same origin and the same family as man, holding a more reasonable philosophy than that of Anaximander. For he declares, not that fishes and men were generated at the same time, but that at first men were engendered in the form of fishes; and that growing up as sharks§ do till they were able to nourish themselves, they then came forth on dry ground.

CENSORIN. *Dies Natal.*, 4, 7.—Anaximander of Miletus believed that either fish, or animals very like fish, sprang from heated earth and water, and that

in following wise: "Der Verfasser geht in seinen Kombinationen oft zu weit: er sucht aus dem dürftigen Material zu viel herauszupressen und lässt in der Ausfüllung der Lücken der Ueberlieferung seiner Phantasie allzusehr die Zügel schiessen" (*Jahresbc. Class. Altertumsw.*, Vol. CXVI., p. 33, 1903).

Moreover, as Dr. Alfred Gudeman has warned us in his interesting essay on 'Literary Frauds among the Greeks' ('Class. Stud. in honour of Henry Drisler,' 1894), much that appertains to the early doxographers is tainted with the suspicion of ungenuineness, or of later interpolation.

* 'Doxographi Græci' (Berlin, 1879). Idem, 'Fragmente der Vorsokratiker, Griechisch und Deutsch' (Berlin, 1903).

† 'Historia Philosophiæ Græcæ,' 8th ed. (Gotha, 1898).

‡ 'The First Philosophers of Greece' (London, 1898).

§ An interesting commentary on the argument here presented, which is recognized as extremely important for the general theory of evolution, is to be found in N. M. Butler's essay: 'Anaximander on the Prolongation of Infancy in Man' ('Class. Stud. in honour of Henry Drisler,' New York, 1894).

§ The reading of *γαλεοί* in place of *παλαιοί* is conjectural, but approved, nevertheless, by the best editors.

human fœtuses grew in these animals to a state of puberty, so that when at length they burst, men and women capable of nourishing themselves proceeded from them.

It will observed that the first four passages stand in substantial agreement with one another, as might be expected from having all been derived from a single source. This work of Theophrastus contained, no doubt, an accurate transcript of the doctrines of Anaximander, since in one instance his very words appear to have been quoted; and as the works of the latter are known to have been in the hands of Apollodorus, there is every reason to suppose that Theophrastus wrote with them lying open before him. When we come to Censorinus, however, we meet with such an absurd and strikingly different version as to leave little doubt that it rests upon a faulty translation of the Greek texts; yet we shall see presently that the majority of modern writers regard this as a faithful rendering of the Milesian's views.

As early as 1819, Heinrich Ritter, to whom we owe the first satisfactory collation of pre-Socratic texts, interpreted Anaximander as having taught that 'after the first imperfect and short-lived creatures had been engendered in slime, an advance took place from the lower to the higher grades of life, until at length man was formed.' Cuvier, whose accuracy and erudition have seldom been called in question, went so far as to attribute to our philosopher the belief that men had been first fish, then reptiles, then mammals, and lastly what they now are. 'This system,' he further remarks, 'we find reproduced in times very near to our own, and even in the nineteenth century.' More conservative is the estimate of Sir Charles Lyell, who while admitting that our philosopher 'made at least some slight approach, twenty-five centuries before our time, to the modern doctrine of evolution,' yet denies that he anticipated the Lamarckian theory of progressive development.*

Edward Zeller, than whom is no more competent authority, speaks in following wise of Anaximander's evolutionary ideas: "The animals, also, he thought, originated from primitive slime, under the influence of the sun's heat; and as the idea of a gradual succession of animal species corresponding with the periods of geological formation was naturally beyond his reach, he assumed that the land animals, including man, had been at first fishes, and afterwards, when they were able to develop themselves under their new shape, had come on shore and thrown off their scales."† Professor Osborn gives practically the same résumé as Zeller, adding, however, that we find in these fragments the 'dim notion of survival or persistence throughout decidedly trying circumstances, which was greatly developed later by Empedocles.' He is unwilling to grant that Anaximander attempted to account for the origin of other land animals, or had any notion of the development of higher from lower organisms, except in the case of man.

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* 'Principles of Geology,' Vol. I., Chap. II.

† 'History of Greek Philosophy,' Vol. I., p. 255 (London, 1881).

Theodore Gomperz, in his work on 'Greek Thinkers,' suggests several influences which may have given definiteness to Anaximander's speculations. For instance, the theory that the first animals were generated in sea-slime is traceable as far back as the Homeric poems, in which water and earth were supposed to be the elements of all organic bodies; and this presumption, the author remarks, 'may have been strengthened by the wealth of all kinds of life contained in the sea, not to mention the discovery of the remains of prehistoric marine monsters.'* As for the casting by primeval animals of their bristly integuments, the same writer observes: "It is likely enough that the analogous change sustained by some insect larvæ may have led him to this hypothesis. We can hardly doubt that he traced the forefathers of the terrestrial fauna from the descendants of these marine animals, thus obtaining a first vague glimpse of the modern theory of evolution." Another ingenious suggestion is that Anaximander, in seeking to explain the origin of human species, drew his analogy from the shark, which 'was popularly believed to swallow her young when they crept out of their capsules, to vomit them forth and swallow them again, and go on repeating the process till the young animal was strong enough to support an independent existence.'

Comment upon the various estimates here brought together appears unnecessary. It is enough that they all present Anaximander to us as a keen and deeply contemplative student of nature, who arrived at a dim adumbration of great truths. Evolutionist or not, as one will, the fact remains that his teachings contain germs of suggestion having high potentiality, which developed in the fulness of time into definite conceptions of organic, and even universal evolution. It is worth while for us to know that hints occur, in that far-off period, of theories of the survival of the fittest, of adaptation to environment, even of evolution as an explanation of the origin of all forms of life. That they remained only hints was inevitable without a knowledge of the essential facts of paleontology. Yet, after all is said, we must grant it was no small thing for Ionic genius to have given the first impulse to lines of thought which have profoundly influenced all departments of human understanding. Nor is it a small thing to realize that our questionings of nature, and indeed our very conceptions of life, re-echo at this day in surprisingly similar manner the questionings and conceptions that occupied the Hellenic mind more than twenty-five centuries ago. As intellectual pioneers, we owe them reverence for having first blazed the way along which all modern thought has followed.

* Numbers of such discoveries are mentioned in pagan literature, some of the remains being interpreted as 'bones of giants,' others as belonging to 'sea monsters.' As late as the second century of our era, Pausanias, who seems to have had a veritable passion for natural curiosities of all sorts, records having seen huge bones in various parts of Greece. Near Megalopolis, where he observed some of them, remains of mammoths and other large extinct animals have been found plentifully in modern times.

THE PHILOSOPHY OF FRIEDRICH NIETZSCHE.

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EVERY once in a while in the history of human thought a man arises who protests against the mass of tradition in custom, law, morality, science, philosophy and religion, and asserts his own individuality. In the presence of the accumulated acquisitions of human minds and human hands, he experiences a feeling of restraint and dependence, he finds his thought and action tied down on every side by the traditional theories and rules of past generations; the weight of ages rests as an incubus upon his soul and he longs for the free and untrammeled use of his head and heart and hands. Unable any longer to bear the burden of the past upon his shoulders, he casts it off, he declares his independence, he asserts his individuality. He wipes the slate clean, and begins to write upon it new thoughts, new values, new ideals, or at least what seem to him to be new thoughts, values and ideals.

Our present age is the historical age *par excellence*. It studies the past and shows us how the present has grown out of this past. It regards everything as the product of evolution, it tells us that we are what we are because our ancestors were what they were, that we do what we do because they did what they did; it traces the development of the thinker, the poet, the statesman, of law, morality, religion, art, literature and science; it justifies our conceptions and institutions on the ground that they have grown from simple beginnings and will develop in their own good time into more and more complex and perfect forms. The individual is the child of the past, in him our grandfathers are speaking to the present, in him their ideals and values are asserting themselves; they are the laws of the present, he is their mouthpiece. Against these conceptions and values a man of our time, Friedrich Nietzsche, has uttered his everlasting No. "Man alone," he says, "finds himself so hard to bear. That is because he carries so many strange things upon his shoulders. Like the camel he kneels down and allows a heavy load to be placed on his back. Particularly, the strong, burden-bearing man, in whom reverence dwells: too many heavy strange words and values he loads upon his back—and now life seems to him a desert." He breaks the old tables of values and demands that new ones be set up in their stead. He is not content with studying the conditions that gave rise to the ideals which we now

uphold; indeed, he regards the historic sense as the cause of the weakness of our times. We must cease feeling that we are *epigoni*. It is the function of the philosopher, in his opinion, to create new values, new ideals, a new civilization. "The real philosophers," he declares, "are commanders and legislators; they say: Thus shall it be; they alone determine the whither and wherefore of man; with creative hands they touch the future—their knowing is creation, their creation is legislation, their will for truth is—will for power." "Blessed it must seem to you to press your hands upon thousands of years as upon wax," says Zarathustra (in Nietzsche's book: 'Thus spake Zarathustra').

What our estimate of the world, of life and of our civilization will be must depend, of course, upon our values, upon our standards, upon our ideal, upon what we really prize. Hence, in order to understand our philosopher and his iconoclasm, we must understand his fundamental proposition, his basal thought, his ideal, the standard with which he approaches things. We shall then be prepared to understand why he objected so strenuously to our times, why he waged such a relentless war against his contemporaries, and earned for himself the title of a *Kämpfer gegen seine Zeit*. I shall not here attempt to trace the development of his ideas and to show how he gradually grew into them. Nor shall I attempt to point out the contradictions in his thoughts or even offer a criticism of them. It will be sufficient for my purpose to find the *motif* of his philosophy, to discover the fundamental principle upon which his thinking rests, and to show how his thoroughgoing opposition to the things around him more or less logically followed from it.

Schopenhauer teaches that the will is the fundamental principle of life. This will to be, this will to live, is a blind striving, a constant struggle for existence, a battle against death which we are bound to lose at last. "The life of most men is a weary yearning and torture, a dreamy tottering through the four ages toward death, with a series of trivial thoughts as an accompaniment. They are like a clock-work which is wound up and goes without knowing why; and every time a man is conceived and born, the clock of human life is wound up anew in order to grind out the same old hackneyed tune which it has played so many countless times before, measure for measure, beat for beat, with insignificant variations." It follows from the very nature of the human will that life should be full of pain and misery. And because it is full of pain, says Schopenhauer, it is bad, it is an evil, and not to be is better than to be. It also follows from the nature of the will that it is selfish and base. Men are knaves or fools or both. The end and aim of the average man's existence is to keep himself alive, and he will do anything he can to eke out his petty life. He is a cruel, unjust and cowardly egoist, whom fear makes honest and vanity sociable. And the only way to succeed in this world is to be

as grasping and dishonest as the rest. Because the will is a selfish will, it is bad, and life is an evil, a curse. In order to be good the will must negate itself, it must give up its selfish strivings. When we feel the sufferings of others, when we pity them, when we see ourselves in them, when we feel that we and they are one, then we are able to negate our selfish desires, we are delivered from the will to live, we are saved, we are at rest. The struggle ceases, we have denied ourselves, we have renounced the world, we are free, our selfish will is dead. Pity or love or sympathy, therefore, is the cause of this negation of will, and hence pity is the fundamental principle of all morality. Sympathy or pity is good because it leads to the negation of the will. The ideal is renunciation, ascetic self-denial; sympathy is the true moral motive, the sole source and standard of morality.

Nietzsche accepts the fundamental thought of Schopenhauer that the will is the principle of existence, but he draws wholly different consequences from this view. Yes, the real fact of our life is the fact of our will. The reality directly known to us is the world of our desires, the world of our instincts, the world of our will. Every living being desires life and desires it extravagantly; its instincts all aim at power and self-assertion. Life is essentially a striving for a surplus of power; all striving is nothing but a striving for power; the will for power is the root of all life and action. And this will for power, for more power, this intense, overflowing, bubbling, healthy, exuberant instinct is good: *Alles Gute ist Instinkt.* Everything that makes for life in this sense is good, everything that makes for power, that helps to realize this goal, is good. "What is good? Everything that heightens the feeling of power in man, the will for power, power itself. What is bad? Everything that springs from weakness. What is happiness? The feeling that power is growing, that a resistence is overcome; *not* contentment, but more power, *not* peace as such, but war, *not* virtue, but efficiency (virtue in the Renaissance style, moraline-free virtue)." "I say yes to everything that makes life more beautiful, more intense, more worthy of being lived. If illusion and error develop life, I say yes to them. If hardness, cruelty, strategy, disregard of others, love of struggle, can increase the vitality of man, I say yes to evil and sin. If I believe that suffering helps to educate the human race, I say yes to suffering. If science and morality diminish vitality, I say no to them."

Life is good, the desire for power is good, yes power is the greatest good. If that is so, then the stronger, the intenser, the fuller this will or desire or instinct for power, the better it is. The ideal will, therefore, always be powerful men, a higher, stronger type of men, the *overmen.* "Mankind should constantly endeavor to produce great individuals—this and nothing else is our mission." The great men, the great personalities, the men of force and power, the few, are the ideal

men, they alone are worth while; the little men, the weaklings, the many, the all-too-many, the mediocre, the half-and-half, the commonplace, every-day people, all these are worthless. "A time will come," says Nietzsche, "in which we shall no longer consider the masses, but again the individuals, who form a kind of bridge over the seething stream of becoming. These individuals are not continuers of a process; they live timeless-contemporaneous lives; thanks to history which allows such cooperation, they live as the republic of geniuses of whom Schopenhauer once said: One giant calls to the other through the intervening spaces of time; and undisturbed by the impish noisy pigmies that crawl at their feet, they continue their high intellectual converse. —No, the *goal of humanity* can not lie at the end, but only *in its highest exemplars.*" "All civilization is the creation of great individuals and for them." "Everywhere among a people we find the traces of the lions of the intellect who have passed through it; in morals, in religion, everywhere the masses have bowed to the influence of individuals." "The great men are necessary, the times in which they appear are accidental." A people is only a roundabout way for producing a few great men. "Neither the state nor the people nor mankind exists for its own sake; the climaxes, the great individuals, are the goal—but this goal points far beyond mankind. From all this it is clear that the genius does not exist for the sake of mankind; he is the climax and final goal of mankind." "Such overmen, such happy accidents, have always been possible and will perhaps always be possible. And even whole families, tribes and peoples may under certain circumstances be regarded as such prizes in the lottery of existence." But nature is surprised herself when she produces such a masterpiece; she is a spendthrift and wastes a lot of material. Mankind should try to produce these geniuses consciously and purposely. The purpose of civilization is to hasten the birth and the development of the philosophers, the artists and the saints within us and without us, and thus to cooperate in the highest perfection of nature. The young man should be taught to regard himself "as a failure of nature, as it were, but at the same time as an evidence of the greatest and most marvelous purposes of this artist; she did not succeed, he should tell himself, but I will honor her great purpose by placing myself at her service that she may have better success at some other time." "I do not look for happy periods in history," says our philosopher, "but for such as offer a favorable soil for the production of the genius. The greatest calamity that could befall mankind would be the failure to produce the highest types of life." "We can by happy inventions educate a wholly different and higher individual than the one thus far produced by accident. Here lie our hopes in the breeding of eminent human beings."

The goal, we see, is the overman, the genius, a higher, stronger,

better kind of man than our every-day man. Now sometimes Nietzsche means what we have said above—the ideal or goal is the creation of great individuals. We have had such great personalities all through history and we shall always have them. Only, their appearance has been more or less accidental, and we should and can produce the conditions favorable to their appearance. At other times, however, our thinker means by the overman a new type of man, a new species in the Darwinian sense, as it were a higher, better, finer species. This type is to take the place of the man that is, just as the man that is has taken the place of the brute. "Man is a rope between the brute and the overman, he is not an end or goal, but a bridge. Upward goes our way, from the species to the over-species." "I teach you the overman," says Zarathustra. "Man is something that must be overcome. What have you done to overcome him? All beings thus far have created something beyond themselves, and you desire to be the ebb of this great flow and to return to the brute rather than to overcome man? What is the ape for man? A mockery and a painful shame. And just that, man shall be for the overman: a mockery and a painful shame. You have made the way from worm to man, and there is much of worm within you still. Once you were apes, and even now man is more of an ape than any ape. See, I teach you the overman. The overman is the purpose of the earth. May your will say: let the overman *be* the purpose of the earth." "My heart is wrapped up in the overman; he is my first and only care—and not man, not my neighbor, not the poorest one, not the great sufferer, not the best. Oh my brothers, what I can love in man is that he is a transition and will pass away."

Here the overman is conceived as a higher, grander, nobler race of men, in comparison with whom our present-day men are as pigmies to giants. Our task is to hasten the coming of the overman. The overman will come, the goal will be realized; only we must not leave his coming to chance. "Could you create a God?" Zarathustra asks. "Then do not talk to me about gods! But you could create the overman. Not you perhaps yourselves, my brothers. But you could transform yourselves into the fathers and forefathers of the overman: and let this be your greatest work."

The ideal then for Nietzsche is the will for power, the will for strong, healthy life as it manifests itself in the great individuals or in a strong race or type of future men. If that is our ideal, if that is what we desire, then we must also desire everything that this ideal implies. Now life is not an easy thing, it is fundamentally and necessarily hard. "Life," says Nietzsche, "is *essentially* appropriation, injury and overthrow of foreign and weaker elements, oppression, hardness, the forcing of one's own forms upon others, the incorporation and at least exploitation, to put it mildly, of foreign elements. Ex-

ploitation is not peculiar to a corrupt or imperfect and primitive society, it belongs to the very nature of living beings; as the fundamental organic function it is the consequence of the real will for power, which is simply the will for life." Life is in its very nature hard and fierce; you can not have life without injury and attack; to live means to appropriate, to assimilate, to exploit, to coerce, to annihilate other elements. Life, the will for power, means struggle, battle, war; it means the exploitation of the weaker by the stronger. From all this it follows that a philosophy that places peace above war is a symptom of decay. If life is hard and fierce, if it is impossible without all these ferocious elements, and if life and power is the ideal, then these things are good. "You shall seek out your foe," says Nietzsche, "you shall wage your war, and for your own ideas, too. And when your idea is vanquished, your integrity shall applaud the deed. You shall love peace as the means to new wars. And the short peace better than the long one. I do not counsel labor, but battle. Let your labor be a battle, let your peace be a victory. You say it is the good cause that justifies the war? I say unto you: it is the good war that justifies any cause. You should have foes only that you can hate, not foes that you despise. You must be proud of your foe, then the triumphs of your foe will also be your triumphs."

In short, life means war and struggle, war and struggle are necessary, inevitable. You can not live and will without asserting yourself, without fighting, without hurting somebody, without being hard. You are bound to be hammer or anvil, you must conquer or be conquered, you must push others to the wall or go to the wall yourself. Life is by its very nature a terrible thing; in order to realize the goal, to produce strong men, it can not but be terrible. "Every moment devours the preceding one, every birth is the death of countless beings; to procreate, to live and to murder are one. We may, therefore, compare glorious civilization to a bloody victor, who in his triumphal procession drags along with him as slaves the vanquished fettered to his chariot wheels." Civilization can not do without the dangerous, hostile and violent passions. "Let envy, hatred and rivalry consume and torture man, let them drive him to extremes. Then perhaps a spark of the terrible energy thus enkindled may fall by the wayside, and from it there may suddenly burst forth the light of genius." "The 'warm sympathetic heart' does not know what it asks when it demands the removal of this violent phase of life; its own warmth is the product of the fire of the very passions which it desires to have suppressed." Whoever affirms life must say yes to the dangerous, violent and hostile phases of it. "The diminution of the hostile instincts is only one of the consequences of the universal decline of vitality." "Hardness, violence, slavery, danger on the highway and in the heart—the fearful, tyrannical, ferocious, serpent-like elements

in man help to improve man." "The serpent must first become a dragon in order that some one may become a hero through it." "Your wildcats must become tigers and your venomous toads crocodiles, for the good huntsman shall have a good chase."

We must make the strong stronger and the weak weaker. The misery of toiling men must even be increased in order to make possible a small number of Olympian men. Whatever will realize the goal is good. The weak must go to the wall, that is unavoidable. "We should not attempt to cure what can not be cured. What is falling we ought even to push down. The weaklings and the failures ought to perish. And we ought even to help them to perish." The world is not a hospital.

Oppression and slavery in some form or other are means to the desired end. "The perfection of the type man has thus far always been the work of an aristocratic society—and it will always be so, the work of a society that believes in a long scale of rank and in a great difference of value between man and man, and finds slavery in some form or other necessary."

Of course, all this means pain and suffering, but remember that happiness is not the end and pity is not a virtue. "My sorrow and my pity—what do I care for these? Am I craving for happiness? No, I am craving for my work." "There are higher problems than all pleasure-, pain- and pity-problems, and every philosophy that culminates in these is a naïve philosophy." "You desire if possible *to do away with suffering;* and *we?*—it seems: *we* desire to intensify it, even to make it worse than it was! Well-being as you understand it—why that is no goal, that seems to be an *end!*—The discipline of suffering, of *great* suffering—do you not know that *this* discipline alone has thus far been the cause of every advance toward perfection in man?" "Such human beings as are near to me I desire to experience suffering, neglect, sickness, ill-treatment, humiliation—I hope that they may become acquainted with extreme self-contempt, the torture of self-distrust, the misery of defeat. I have no pity for them, because I wish them the only thing that can prove in our day whether a man has *worth* or not—*that he fight it out.*" "The most spiritual men also suffer by far the most painful tragedies; but for that very reason they honor life, because it places against them the greatest foes. It almost determines the scale of one's worth how deeply one can suffer." "The man who has become free, and much more the spirit that has become free, tramples under foot the despicable kind of well-being of which grocers, Christians, cows, women, Englishmen and other democrats dream. The free man is a *warrior.*"

The fact is, man does not seek pleasure or happiness, nor does he avoid pain. What man wants, what the smallest part of a living organism wants, is more power. For what do the trees in the forest

struggle with each other? Certainly not for happiness, but for power. Pain as an obstacle to man's will for power is a normal fact, the normal ingredient of every organic occurrence. Man does not avoid pain, he needs it; every victory, every feeling of pleasure, every occurrence, presupposes a resistance overcome. The psychologists have not distinguished between the pleasure of falling asleep and the pleasure of victory. The exhausted want rest, they want to stretch out their weary bones, they want peace and quiet—it is the happiness of the nihilistic religions and philosophies. The robust and active natures desire victory, they want to overcome opponents, to extend the feeling of power over wider areas than before. All healthy functions of the organism have this need—and the whole organism is such a complexus of systems striving for the increase of the feelings of power. "To be preoccupied with oneself and one's everlasting salvation is *not* the expression of a perfect and self-confident nature, for such a nature doesn't care a straw whether it is to be blessed or not—it has no such interest in happiness of any kind, it is power, action, desire—it puts its impress upon things."

Life in short is hard and cruel and can not help being so; it is full of suffering. But we must not only learn to suffer ourselves, we must learn to see others suffer, yes to make them suffer where it is necessary. "Who can achieve anything great unless he feels the power and the will in himself to *inflict* great pains? The ability to suffer pain is the very least; weak women and even slaves often become masters in this. But not to perish of grief and distrust when we inflict great suffering and hear the cry of anguish—that is great, that is a part of greatness."

We must not only bear suffering in ourselves and be brave enough to inflict it upon others; we must not pity it. Schopenhauer had made pity or sympathy the sole basis and standard of morality, because it is the negation of the selfish will to live. For that very reason Nietzsche repudiates pity. In the first place pity is by no means so disinterested and admirable a feeling as the moralists make it. The weakling pities those who are beneath him, who do not compete with him, whom he need not fear—it increases his self-love to pity. Pity is the virtue of mediocre souls. Pity is one of the saddest symptoms of decline. Moreover pity crosses the law of evolution which is the law of selection. It preserves what is ripe for destruction. Suffering itself becomes contagious through pity. It augments misery and preserves everything that is miserable, and so becomes the chief means for intensifying decadence. "What is falling we should even push down." "Oh my brothers, am I then cruel? But I say: what is falling we should even push down! All these things of to-day—they are all falling, they are all decaying; who would keep them from it? But—I would even push them. And him whom you do not teach to fly, why teach him—*to fall*

faster!" "What is more harmful than any vice? Active pity with all failures and weaklings." "War and courage have done more great things than love of neighbor. Not your pity, but your courage, has saved the unfortunate thus far. What is good? To be brave is good. Let the little girls say: good is what is both pretty and touching." "There is a stage of morbid softness and effeminacy in the history of society at which it even takes the part of him who injures it, the criminal. To punish—that somehow seems unjust to it—it is certain that the notion of 'punishment,' of a 'duty' to punish, causes it pain, terrifies it.—Is it not enough to render him *harmless?* Why punish anyhow? Punishment is so terrible."

Pity therefore is bad because it hinders the realization of the ideal: the development of the will for power, the creation of strong men, of great individuals, of powerful personalities. It is not an admirable quality, but characteristic of base, petty souls, of weaklings and decadents. It increases misery and suffering, and diminishes life-energy, and by so much weakens the desire for life and power. It hinders the weak from being eliminated as they ought to be, and so interferes with the proper working of the law of life: the destruction of everything that is not worth saving. Yes, it even preserves the sick, the weak, the failures, the decadents, the degenerates, and makes the world uglier, an eye-sore to the strong and efficient. Pity is a temptation and a danger. "We should put the rein to our hearts; for when we let them go, how they run away with our heads. Alas! where in the world do greater follies happen than among those who pity? And what in the world has caused more suffering than the follies of the pitying?—Myself I sacrifice to my love and *my neighbor as myself*—that is the word of all creators. All creators, however, are hard."

Egoism is worth just as much as the person is physiologically worth who has it. Every individual represents the whole line of development. If he is an advance on this line, then his value is extraordinary, and the care for his preservation and for favorable conditions of his growth may be extreme. But if he represents a retrogression, decay, chronic disease, he has little value, and it is only fair that he take away as little elbow-room and power and sunshine from the sound and healthy ones as possible. In this case society has for its task the repression of egoism. From this point of view a doctrine and religion of love, of repression of egoism, of forbearance, of resignation, can have the highest value because it teaches the weak and sick to keep out of the way of the strong, to let themselves be ruled by the strong. But it must not be forgotten that altruism is a symptom of weakness; the weak and feeble preach love of neighbor and benevolence because they need help themselves. The worship of altruism is a form of egoism; it is the egoism of the failures.

We see, Nietzsche portrays the world as a terrible thing. Life is

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full of danger and battle and pain and cruelty. In this he agrees with Schopenhauer. He is not an optimist in the sense of finding everything pleasant and easy and good; it is not a world of sunshine and perpetual joy in which we are living, but a battlefield, a terrible battlefield reeking with blood. But Nietzsche does not conclude from this that we should therefore negate life, that we should fly from it, that we should renounce the world, that we should throw down our arms and give up the fight. All pessimism is a sign of decadence, the expression of a weak will, of a degenerate instinct. The strong and healthy man wills to live—in spite of all suffering and sorrow he wills to live, yes, as we have seen, these very sorrows he makes the means of an intenser, fuller life. "Praised be what makes us hard! I do not praise the land where milk and honey flow." Nietzsche's pessimism is a spur to the will; "with this will in our breast we do not fear the terrible and questionable in all existence, *we seek it out.*" "How did I endure it," he asks, "how did I recover from such wounds? How did my soul again rise up out of these graves? Yea, there is something in me that can not be wounded, that can not be buried, something that can move mountains: that is my *will.*—Yea, thou art still the destroyer of all my graves: Hail to thee my will! And only where there are graves can there be resurrections."

And because the desire for life and power means self-assertion, will-action, the realization of instincts, asceticism or renunciation or the suppression of instinct is bad. Non-being can not be the goal. Asceticism is a symptom of exhaustion, of weakness of will and degeneracy. There are many forms of asceticism, but all of them ask man to negate his natural instincts, to cease desiring or willing, to do the very thing which according to our philosopher will hinder the realization of life and the higher type of man. "That, however, the ascetic ideal has meant so much for man is an expression of the fundamental fact of the human will: its *horror vacui;* it needs a goal—and it would rather will the *nothing* than *not* to will at all." But deliverance from life, negation of the will, nirvana, is not the goal, but life, more life. Only when asceticism furthers life, when it makes the will stronger, when it serves as a gymnastic of will, is it good.

Let us now turn to Nietzsche's anti-democratic teachings and see how they follow from his fundamental principle. If life and power are the ideal, then the strong wills, the great personalities, the higher types of man, the happy few, are better than the many, the masses, the weaklings, the failures, the degenerates. Men are not equal, and it is impossible for them to be made equal. The democratic ideal of equality is a dream. "There is no more venomous poison than the doctrine of equality, for it *seems* to be preached by justice itself when in fact it is the *end* of all justice." The equality-theory would make of man a dwarf-animal of equal rights and privileges. The herd, of course, is

hostile to gradations of rank; its instinct is in favor of leveling and against the strong individuals, the sovereigns. But, as we have already seen, life is so constituted that some must rule and some must be ruled. The leveling mania is the result of the hatred of the weak for the strong; it means the destruction of power, of will, of individuality. "You preachers of equality, the tyrant's fury of impotence cries out of you for equality; your most secret tyrant-lusts thus masquerade in words of virtue. Offended arrogance, suppressed envy, perhaps your fathers' arrogance and envy: out of you it breaks forth as a flame and as the fury of revenge." The strong man, the genius, should not be sacrificed for the masses. Nay the reverse is true, the masses should be sacrificed for the genius. "The greatness of an advance is measured by what had to be sacrificed for it. Humanity, as a mass, sacrificed to the welfare of a single stronger species man, that would be an advance." "The essential characteristic of every good and healthy aristocracy is that it does not regard itself as the function of the community, but as its aim and highest justification, that it accepts with a good conscience the sacrifice of a countless number of human beings who must for its sake be degraded into incomplete men, slaves, tools."

Therefore all democratic, socialistic, communistic and anarchistic dreams are idle, nay, hostile to life. If men are not equal, they should not be treated as equal. "Equality of rights leads to equality of wrongs. Every right is a privilege." "Equal rights to equals—unequal ones to unequals, that would be the true doctrine of justice: and what follows from it—never to make the unequal equal." All attempts to make the masses, the laborers, equal to the leaders must fail and ought to fail. "For my brothers: the best shall rule and the best *will* rule! And where the teaching is otherwise, *there are no* best." We need men who will carry out the behests of the leaders, we need executives for the choicest spirits, we need hewers of wood and drawers of water, and there never will be a condition of society when this will not be the case. "Oh my brothers, I consecrate you and point you to a new nobility: you are to be producers and propagators and sowers of the future—verily not to a nobility that you can buy like shop-keepers and with shop-keeper's gold; for little value has everything that has its price.—Oh my brothers, not backwards shall your nobility gaze, but *beyond!* Ye shall be driven out of all father- and forefather-lands. Your children-land shall ye love: this love be your new nobility—the undiscovered land in the farthest sea: to that I bid ye stretch your sails." An aristocratic society of this kind is a necessity of nature, the best must rule, and such an aristocracy makes slavery in some form or other necessary. And, after all, our laborers are no happier than the slaves of Pericles. The original state of nature was not an age of equality, as Rousseau taught, but an age of inequality, and the distance between man and man will be greater instead of less in the future.

The state was in its beginnings probably a terrible tyranny which a hord of mighty beasts of prey combining for rapine and plunder forced upon a peaceful, but poorly organized mass. The modern state, the so-called ideal or paternal state, the idol of the age, is opposed by Nietzsche because it endangers the individuality of creative minds. The ideal state of the socialists is really hostile to life, it is the destroyer of man, it is a crime against the future of man, a sign of exhaustion, a stealthy path to nothingness. It corrupts the soil on which genius grows, it would make humanity tame and uninteresting and happy.

But Nietzsche does not oppose the state as such, he is not an anarchist. He believes in authority, indeed he maintains that healthy vigorous life is not possible without authority. The rabble ought to be made to understand that there are sacred things which they ought not to touch, in the presence of which they ought to take off their shoes and from which they ought to keep their unclean hands. "The society of men is an experiment, a long search; but it *searches for the ruler.*" This ruler is not a brutal arbitrary tyrant, he is strict with himself and gentle with the weak and suffering. He is a man who says: "This pleases me, this I shall take and defend against everyone," "a man who can lead a cause, carry out a resolve, be loyal to an idea, hold fast a woman, punish and overthrow a rascal; a man who has his anger and his sword, and to whom the weak and suffering and oppressed and even animals gladly turn and naturally belong, a man in short who is by nature a *lord*—if such a man has pity, very well! *This* pity has value. But what care we for the pity of those who suffer. Or of those who even preach pity."

For the same reason that Nietzsche opposes the modern democratic tendencies he is against the so-called emancipation of women. The sexes are not equal. Man's strongest instinct is the desire for power; woman's whole life is love, which is merely an episode in man's. "The happiness of man is: This is my will. The happiness of woman is: This is his will." She is made to love and obey, he is made to rule and protect. "Man should be trained for war, and woman for the recreation of the warrior: everything else is foolishness." Where this natural and healthy relation is perverted, where the man is effeminate and the woman masculine, we have decay. "There is too little of the man around here," says Zarathustra, "therefore their women become mannish. For only one who is man enough will *deliver the woman in woman.*"

We are now prepared for a discussion of Nietzsche's conception of morality, one of the most important phases of his teaching. Nietzsche declares that thus far no one has dared to make morality a problem, to criticize it, to call it in question. "The value of these values (those expressed in the moral laws) has been accepted as a matter of fact, as beyond all dispute. In the entire science of morality so far the prob-

lem of morality itself has been absent, even the suspicion has been wanting that there was anything problematical about it. What the philosophers call explanation of morality is merely only a learned form of the firm belief in the prevailing morality, nay, even a kind of denial that morality can be conceived as a problem." But we must examine the prevailing morality; if it really is morality, there will be no danger in such an investigation: whatever can not stand the test must go.

Now such an examination reveals to Nietzsche the perversity of traditional morality. Schopenhauer teaches that pity or sympathy is the basis and standard of morality. Yes, says Nietzsche, pity is the basis of our traditional morality, and therefore our traditional morality is bad. Pity is the negation of healthy egoism, the negation of the desire for life and power; it means renunciation of self, self-denial, self-sacrifice, the suicide of our life-preserving instincts, and therefore pity is bad, and the morality that is based on pity is a symptom of decline. Take out pity and the whole structure of our traditional morality crumbles to pieces. Pity is not a good, as we have already been told, pity is not good because it violates the fundamental principle of existence, the desire for life, the desire for power, and hinders the realization of the true goal: the development of strong men. The morality that is based on pity has corrupted humanity; it teaches men to despise the basal instincts of life, it sets the highest value on unselfishness, the typical goal of decline. "*Entselbstungsmoral* is the typical decadence-morality *par excellence*." The desire for life, for more life, the strong affirmation of life, is the basal law of existence; the production of strong individuals or a strong species the goal, the ideal to be realized, the highest good, the value of values. On this principle our new morality must be based; we must create new values in the light of the highest value; we must transform or re-value, re-evaluate, the old values, reform the traditional morality. Not sympathy-morality, but will-morality, instinct-morality, that is the end.

Our present morality, our pity-morality, is the morality of slaves, the true morality, the will-morality, is the morality of lords, *Herrenmoral*. The slave-morality, the pity-morality, represents the ideals of the weak and oppressed, it incorporates the rules which they desire to be followed in order that they may live their paltry lives in peace. Virtue is for these little people what makes men tame and modest; in this way they have changed the wolf into a dog and have transformed man himself into man's best domestic animal. It is based on their hatred and fear of the lords, the strong, the aristocrats; it represents the instincts of the herd against the strong and independent, the instincts of the sufferers and the failures against those who have succeeded, the instincts of the mediocre, of the average, against the exceptions. These little people call pity of the weak good because they are

weak themselves and need protection; they call the healthy egoism of the lords bad because the lords push them so hard. Their morality is the morality of gregarious animals, *Heerdentiermoral,* it is the morality of the timid, weak and sick; their virtues are the virtues of the herd, and these are praised because they preserve the herd.

But all that is perverse; the traditional pity-morality is a degeneracy. Life, the affirmation of life, the exercise of healthy robust instincts, is good. Life, more life, intenser, fuller life, is the demand. This is clearly brought out in the relations which the states assume to one another; societies do not follow the pity-morality in their treatment of other societies, they are not altruistic towards each other. The study of society is so valuable because man as society is much more naïve than man as individual. Society has never looked upon virtue as anything but a means of power, strength and order. Outwardly, in its dealings with other collective bodies, the herd is hostile, selfish, merciless, greedy for rule, full of distrust.

The lord or strong man, the aristocrat, feels that life is good, and calls everything that makes for his ideal good. He and his equals, the robust natures, are good; their self-assertion, their self-glorification, their love of life, their will for power, their desire for struggle, that is good. The strong and noble despise the weaklings, the slaves; these are *schlecht,* low, base, plebeian, vulgar. The very word *schlecht* means low, base, common, of low descent, despicable. It expresses certain incapacities which are physiologically connected with the type of degeneracy: *e. g.,* weakness of will, vacillation, inability to check the reaction to a stimulus and to control oneself, lack of freedom in the presence of any kind of suggestion on the part of another's will. Fear, cowardice, flattery, baseness, humility, mendacity and weakness are the qualities of the base-born.

Whatever tends to preserve and develop the robust men, the great individuals, the higher type, is good, whatever tends to hinder the realization of this end is bad. The qualities which make for the preservation of the good type are good, whatever acts and qualities tend to keep the stock pure are right. Hence the lords have no duties to their inferiors, but only to their equals. Indeed, the massess are merely so much food for the geniuses, the necessary background and instrument for the higher types. They do not count. The aristocrat fixes the values, and he values himself alone.

It is not correct to say that Neitzsche is a moral nihilist, that he repudiates all morality. He does repudiate the traditional morality, but sets up in its stead a new morality, the *Herrenmoral,* which, as he believes, is the morality of health and power, the original morality, which was displaced by the slave-morality, a heritage of the Jews. Indeed, the main thing for him after all is the principle that should underlie all morality, the principle of the higher type. "I do not

deny," he says, "that many acts which are called immoral are to be avoided and combatted, likewise that many which are called moral ought to be performed and encouraged—but I think these acts ought to be performed or avoided for different reasons from those given hitherto." Nor does Nietzsche preach a code of license and caprice. His ideal man is not a man of license, an unrestrained force, a wild and lawless savage. He does not wish to bring back the 'blonde beast' of early times, the 'human beast of prey,' the tyrant, the despot, the usurper. "The noble man," he says, "honors in himself the man of power, the man also who has power over himself, the man who can speak and keep silent, who delights in being strict and hard with himself and has respect for strictness and hardness everywhere. Confidence in oneself, pride in oneself, belong to aristocratic morality." "As soon as the noble or aristocratic soul is clear on the question of rank, he moves among his equals and those having equal privileges with the same confidence and gentle reverence which he reveals in his intercourse with himself—he honors himself in them and in the rights which he grants them, he does not doubt that the exchange of honors and rights constitutes the essence of all intercourse and the natural condition of things." What is freedom? "That we have the will to take responsibility. That we keep the distance which separates us. That we become more and more indifferent to toil, hardness, privation, yes even to life itself. That we be ready to sacrifice to our cause human beings, ourselves not excluded. Freedom means that the manly, the warlike and the triumphant instincts dominate the other instincts, for example, the instincts for 'happiness.'" The ideal of personality can only be realized by self-discipline. All morality is a long compulsion. "You ought to obey some one or other and for a long time, otherwise you will go to pieces and lose your self-respect." When you obey yourself, when you are a law unto yourself, then you are a free man. Your act should be your act, the expression of your personality, your self ought to be in it as the mother is in her child. Those are commanded who can not obey themselves, who can not control themselves. "Alas! there is so much lust for fame! There are so many convulsions of ambition! Show me that you are not one of the lustful and ambitious! Alas! there are so many big ideas, they do nothing but inflate like bellows: they blow up and make more empty. You call yourself free? Your controlling idea let me hear and not that you have shaken off a yoke. Are you one of those who had the right to throw off the yoke? There is many a man who threw away his last worth when he threw away his obedience. Free from what? What does Zarathustra care for that! Clearly however your eye shall tell me: Free *for what?*"

A great man, a heroic man, a good man, is better than a weakling,

a decadent and a fool. "From time to time," exclaims Nietzsche, "grant me but one look upon something that is complete, something that is finished, something perfect, mighty, triumphant, something in which there is still something to fear. Upon a man who justifies *man*kind, upon a complementary and redeeming accident of man, for whose sake we can hold fast to our *belief in mankind.*" That nature can produce a single man of this type is a consolation to Nietzsche, is enough to fill him with admiration and joy. He would agree with old Heraclitus: "To me one man is ten thousand if he be the best."

Traditional morality is repudiated by Nietzsche because and in so far as it contradicts the principle of life. For the same reason he rejects religion, particularly the Christian religion. The leading religions, he thinks, cause the race to deteriorate, they preserve too much of what ought to perish. Christianity, especially, is a crime against life. It falsifies, negates and depreciates reality. It preaches asceticism, the denial of life, pessimism, pity, effeminacy, contempt for the world, peace, non-resistance, opposition to struggle, equality and original sin. It is hostile to nature and the natural healthy instincts, calling them sinful; it glorifies the weak and sick and would have them rule over the strong; it tries to make the unequal equal; it destroys man's pleasure in himself and in the world; it is the religion of the decadent, of the played out, of the unnerved. In short, it condemns and negates this life, and points us in its stead to fictions of another world: to God, an immortal soul, a future life and a free will. It has nothing but imaginary causes (God, soul, ego, spirit, free will); nothing but imaginary effects (sin, redemption, grace, punishment, forgiveness of sins); an intercourse between imaginary beings (God, spirits, souls); an imaginary natural science (anthropocentric: complete absence of natural causes); an imaginary psychology (repentance, pangs of conscience, temptation of the devil, the proximity of God); an imaginary teleology (the kingdom of God, the last judgment, eternal life). This entire world of fictions has its root in Christianity's hatred of the natural (the reality), it is the expression of a profound contempt for reality. But that explains everything. Who alone has reason to *lie himself out* of reality? He who suffers from it. But to suffer from reality is to be a failure of reality. The surplus of the pain-feelings over the pleasure-feelings is the cause of that fictitious morality and religion—such a surplus, however, represents the formula of decadence. Christianity is the insurrection of the failures; it is the religion of the lower classes, women, slaves and plebeians. "Every philosophy that places peace above war, every ethics that gives the notion of happiness a negative form, every metaphysics that makes a state of equilibrium and final rest the goal of development, every esthetic, ethical or religious yearning for a better

world, for some 'hereafter' or other, is radically, perhaps nothing but a symptom of degeneracy."

His own religious feeling Nietzsche expressed in what he called *amor fati,* the love of fate. "My formula for the greatness of a man," he says, "is *amor fati:* that he desire to have nothing except what he has, not in the future nor in the past nor for all eternity. Not only to submit to necessity, least of all not to hide it from himself—for idealism is falsehood, mendacity in the presence of necessity—but to love it." "Verily through many souls have I passed and through hundreds of cradles and pains of labor. Many a farewell have I spoken; I know the heart-breaking last hours. But my creative will, my fate wills it so. Or to put it more honestly: such a fate is just what my will desires. Will is a deliverer, that is the true doctrine of will and freedom." "A new pride my I has taught me and that I teach men: no longer to hide my head in the sand of heavenly things, but to carry it freely, a head of earth, which realizes the purpose of the earth. A new will I teach men: to desire this path which man has blindly trod, and to call it good and no longer to steal away from this path like the sick and dying."

Nietzsche's estimate of the intellect, of knowledge, of philosophy and science, of truth, is based on the same fundamental thought. The will for power, the desire for life is what counts. Instinct, desire, will, are better than knowledge or intelligence as such, or conscious intelligence rather. The mind or intellect is merely an instrument in the hands of instinct, of the will for life and power. "Behind your thoughts and feelings, my brother, stands a mighty ruler, an unknown sage—and his name is self. He dwells in your body, he is your body." Your intellect or mind is the 'little reason,' it is the tool of your body—the creating body created the mind as a hand of its will—your body and its instincts is the 'big reason.' "I am wholly body and nothing else; and soul is but a word for something belonging to the body." "There is more reason in your body than in your wisest wisdom." Mind or knowledge has value only in so far as it makes for life, in so far as it helps you. Now truth does not always help you, it is sometimes harmful; illusion sometimes helps you. If illusion helps us, we want illusion. Nietzsche even goes so far in his opposition to the popular view as to say that illusion is as necessary as truth. "The falseness of a judgment," he says, "is no objection against a judgment. The question is how far it preserves and promotes life, preserves the species, perhaps even develops the species, and we are inclined to assert on principle that the falsest judgments are the most indispensable ones for us, that without assuming logical fictions man could not live, that to give up false judgments would be to give up life, to negate life."

It is a prejudice of the philosopher that truth is more valuable

than error. To put truth above error and illusion, to love truth for its own sake instead of as a means of life, is turning things upside down, is a diseased instinct. Indeed this ideal of truth for truth's sake is only another form of asceticism, it is a denial or negation of life for something else.

Besides, Nietzsche goes on to tell us, there is no universial truth anyhow, there are no eternal truths, no truths accepted by all. The propositions that have been offered as truths are errors. Thinking is really inaccurate perception, it looks for similarities and overlooks differences, thereby producing a false picture of reality. There is no such thing as substance, there is nothing permanent; there is no universal causal nexus; there is no purpose in nature, no definite goal. The universe does not care for our happiness of morality, there is no divine power outside that can help us. Our vanity of course hinders us from accepting the view that there is no purpose, no goal in the universe. "The total character of the universe is for all eternity chaos, not in the sense that necessity is wanting in it, but in the sense that it is without order, organization, beauty, form, wisdom and whatever else our esthetic anthropomorphism may put into it. Judged by our reason the misses are the rule, the exceptions are not the secret goal, and the whole play eternally repeats its air which can never be called a melody; and finally the expression *unlucky throw* or miss, is a human way of talking which implies reproach. But how can we either praise or blame the All?" "Man is a little exaggerated animal that—fortunately—has had its day; life on the earth is only a moment, an episode, an exception without consequence, something that has almost no significance for the total character of the earth; the earth itself, like every star, is a hiatus between two nothings, an event without plan, reason, will, self-consciousness, the worst kind of necessity, *stupid* necessity. Against this view something in us protests; the serpent vanity persuades us: 'all that must be false for it makes us indignant. Could it not all be mere semblance?'"

All these propositions, then, that have been accepted as universal truths are merely errors and illusions, phantoms of the imagination; the belief in a God and in a supersensuous world, in an abiding world, is an illusion. Knowledge is a tool for power. The utility for preservation is the motive behind the development of the organs of knowledge. We arrange the world so in our thoughts as to make our existence possible; hence we believe in something permanent and regularly recurring. We reduce the confused plurality of experiences offered to us, to a rational and manageable scheme by means of formulas and signs which we invent; the purpose being to deceive ourselves in a useful way. In this sense the will for truth is the will to become master of the plurality of sensations—to string the phenomena on certain categories. A species understands so much of reality as is

necessary to master it. Hence logic and the categories of reason are simply a means of arranging the world for utility purposes, of arranging it so that we can handle it. But the philosophers have made the mistake of regarding these categories, these formulas, these handy forms, as criteria of truth, as criteria of reality; they have naïvely made this human way of looking at things for the sake of preservation, this anthropocentric idiosyncracy, *the measure of things,* the standard of the 'real' and 'unreal.' And in this way it came to pass that the world was divided into a real world and a seeming world, and that the very world to live in which man had invented his reason, this world of change, of becoming, plurality, opposition, contradiction, war, was discredited and calumniated, that it, the real world, was called a world of semblance, a mere appearance, a false world, and that the invented fictitious world, the alleged world of permanence, the unchanging, supersensuous world, the false world, was enthroned as the true world.

All we do know directly is the world of our desires and instincts, and all our instincts may be reduced to the fundamental instinct—the will for power. Every living being strives to increase its power by vanquishing other beings; this is the law of life. Indeed, every specific body strives to become master of the whole of space and to extend its force (its will for power), and to repel everything that resists its extension. But it constantly meets with similar strivings of other bodies and ends by falling in line ('uniting') with those that are sufficiently related to it—and they then conspire for power together. The world is a monster of force without beginning or end, a fixed iron quantity of power which does not become greater or less, which is not used up, but transformed, a household without income or outgo. And this world repeats itself forever and forever. All things return eternally, Nietzsche teaches, and we ourselves with them; we have been here before an infinite number of times and all things with us; and we and all things shall come again eternally, shall live over again the same lives even to the smallest details. The knot of causes returns in which I am tied—that will create me again. I shall come again, with this sun, with this earth, with this eagle, with this serpent—not to a new life or a better life or to a similar life, but to this same life. "And this slow spider which is crawling along in the moon-light, and this moon-light itself and I and you in the doorway whispering to each other, whispering about eternal things—must we not all have been here before? and must we not all come back again, and walk in that highway of eternity stretched out there before us, in that long and hideous high-way must we not return eternally."

These are the fundamental ideas of Friedrich Nietzsche. As we have seen there is a central thought running through his entire work, an ideal, that is they key to his whole philosophy of life and helps us

to understand this remarkable thinker and his opposition to our age. The will for power is the fundamental human instinct, the fundamental human fact. The goal is the creation of a higher type of men, of a race of heroes, as it were. Life in the real sense of the term is impossible without struggle, it is a struggle for existence. Hence war is preferable to peace, indeed peace is a sign of death. War and struggle of course are hard, they bring out the stern elements in man, they can not be carried on without injury, pain and suffering, without hurting the weak. But since all these things are inevitable, since no strong race can be produced without the desire for power, which implies war, struggle, pain, suffering, injury to the weak, they are good and their opposites bad. We must fight, we must inflict injury, we must suffer our pain, because life is impossible without these things. "It is customary nowadays," he says, "even under the guise of science to prate about coming conditions of society which shall be lacking in the ferocious features. That sounds to my ears as though it were intended to invent a life that dispensed with all organic functions." We are not here for our pleasure, for our happiness, we are not here for any purpose, but being here we must hold our own, we must assert ourselves, or go down. Therefore pity is bad, it injures him that gives and him that takes. It saps the strength of the race, it weakens both the strong and the weak, and is bad.

It is true that life is terrible, but that is no reason for pessimism. Indeed, pessimism, renunciation, is impossible except in a diseased and degenerate race, for the desire for life is too strong in a healthy mind to be overcome by pain and battle. Again, life is struggle, it means victory for the strong and defeat for the weak; somebody must win and somebody must lose. It is an experiment, a sifting process in which the sheep are separated from the goats. It is selective, aristocratic. It brings out the inequalities in human nature, it shows that men are not equal. Some men are better than others, stronger in body and mind. The better men, the natural-born aristocrats, should have more privileges because they have more duties than the plebeians, the rabble. The best men should rule. Hence democracy, socialism, communism, anarchism are all impossible, they all contradict the ideal, they all make impossible the development of strong individuals. Slavery in some form or other has always existed and will always exist. The modern laborer has simply taken the place of the ancient slave. Nor can women have the same rights as men because they are not equal to men in initiative, in energy, in will. Our greatest danger to-day lies in the mania for equality. "For thus it stands," says our thinker, "the dwarfing and leveling of the European man constitutes our gravest danger, for this outlook wearies us. We see nothing to-day that promises to become greater, we are vaguely suspicious that things are going down, down, that everything is becoming thinner, more

good-natured, more prudent, more comfortable, more mediocre, more indifferent, more Chinese, more Christian—man, there is no doubt, is becoming 'better' and 'better.' Just here lies Europe's danger: with our fear of man we have also lost our love for him, our reverence for him, our hope in him, yes our desire for him. The sight of man now wearies us—what is nihilism to-day if it is not that? We are weary of *man*."

"We have invented happiness, say the last men and blink their eyes. They have left the regions where life was hard, for they need warmth. They still love their neighbors and rub themselves on them, for they need warmth. To become sick and to be distrustful they regard as sinful, they walk circumspectly. A fool who still stumbles over stones or men: A little poison now and then, that makes pleasant dreams. And much poison at the end, for a pleasant death. They still work, for work is a source of amusement. But care is taken that the amusement be not too severe. They no longer grow rich or poor; it is too troublesome. Who is willing to govern? Who is willing to obey? All that is too troublesome. No shepherd and one flock. Everybody desires the same, everybody is equal: whoever thinks otherwise voluntarily goes to the insane-asylum. Once the whole world was insane, say the choicest and blink their eyes. They are wise and know everything that has happened; so they go on mocking. They still quarrel with each other, but they soon become reconciled—otherwise it would spoil their digestion. They have their little pleasures by day and their little pleasures by night; but they take care of their health. We have invented happiness say the last men and blink their eyes."

Our traditional morality is also rejected by Nietzsche because it is based on pity and favors the weak and decadent against the strong. Religion, too, particularly Christianity, is repudiated for the same reason and his contempt for science and philosophy is to be explained in the same way—by his glorification of the will for power. Peace, happiness, pity, self-denial, contempt of the world, effeminacy, non-resistence, socialism, communism, equality, religion, philosophy and science, are all rejected because they contradict life, and all systems of thought and all institutions which regard these things as valuable and worthy to be sought after for their own sakes are symptoms of decadence.

THE STUDY OF LOCALITY.

By CEPHAS GUILLET, Ph.D.,
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A SIMPLE statement of what can be done and has been done with children is attempted in this article by one who for five years maintained a school in Ottawa for boys, limited in number to twenty and ranging in age from eight to fourteen years.

The afternoon work of this school was conditioned by the season. In the fall, the topography and physiography and the geological history of the city and surrounding country were studied The crust of the earth was examined in outcrops, mines, quarries and excavations, and collections made of soils, shells, fossils and animals for museum, vivarium and aquarium.*

In the winter when animate nature is in a state of torpidity and the earth covered with a mantle of snow, the conditions are less favorable for outdoor study of nature. As nature is asleep, we study her asleep. The forest in particular is a convenient and interesting object of winter study. We observed the general appearance of the tree-skeletons, striving to fix in our minds by memory-drawing the characteristic shapes of the various deciduous trees. We examined the bark of the trunk, the character of the wood (making collections of various woods), the size, form, color, texture, taste and smell of the twigs and buds, and the number and arrangement of the buds. The character of the terminal twigs is an excellent means of distinguishing our trees and shrubs. The various contrivances by which the buds protect themselves are of great interest. The buds, being kept in water, open out, showing how ready they are to cast off their winter clothes when the moisture and warmth of spring shall come.

Approaching Christmas reminded us of the evergreens, which we learned to distinguish, the boys decorating their desks with them. In this connection, I shall describe a typical winter outing. A few days before school closed for the winter holidays, we went to a rugged, swampy brush in search of evergreens, each boy being assigned a particular kind to be responsible for, while all were on the lookout for the rarest in the neighborhood, namely, ground hemlock or American yew. Joyously shouting defiance to the frost king, they trudged over the ridges, plunged down into the gullies, and ran across the tiny ponds. Skirting one of these, they at last found the ground hemlock nestling

* For a full account of the fall work in nature study, see 'A Glimpse at a Nature School,' in *The Pedagogical Seminary* for March, 1904.

at the foot of the taller balsam and spruce. Then one of the boys made the merry discovery of the orange berries of the climbing bittersweet shining brilliantly against the bright green of a tall spruce, which it clasped in its tight winding embrace to the very top, while hanging its beautiful clusters down in rich and graceful festoons. At once there was a clambering and a pulling till we had added these gay wreaths to our varied evergreens. Such an outing puts iron into the blood and glad memories into the heart.

One of our favorite haunts was a piece of bush called Beechwood. Last winter we undertook to make a valuation survey of it on snowshoes. We first marked off a strip by tramping from one end of the woods to the other in Indian file. Then we counted all the trees in that strip, but recorded the measurement only of those of a circumference, breast high, of 36 inches or more. Two boys were assigned to each of the principal trees, one of them using the tape while the other kept tally. In the case of the boys in the illustration, it is evident that two of them are measuring one of the large beeches. In this way, we covered the whole woods in four afternoons, and found it to contain 670 trees, of which 270, or 40 per cent., were at least three feet around. All the trees but 90 and all the large trees but 30 were maple, beech and basswood, there being as many large maples as large beeches and basswoods together. The other trees present we found to be elm of two species (American elm and slippery elm), ironwood, yellow birch, hemlock, butternut and white ash.

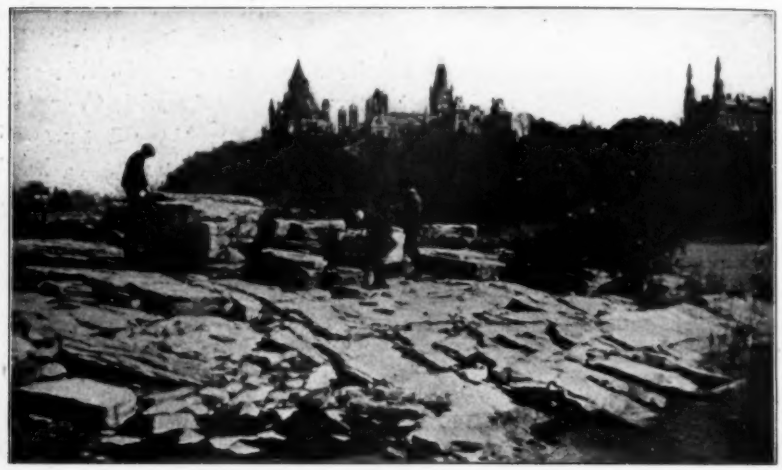
At the school, we worked out the diameters of the trees whose circumference we had recorded, and then with the aid of lumbermen's tables found the total contents in board feet of the three most numerous species. Counting the lumber as worth $12 a thousand, we soon found out the value of the standing timber of our little woods to be about $800. Meanwhile, with compass and pencil in hand we had ascertained the shape and size of the wood, made a chart of it and estimated it to contain about eight acres.

In the spring, we studied the character of the underbrush and of the soil cover and indicated with proper surveyor's signs the large wooded portion, the two small open grassy corners, the marshy ground, the hill and the paths. Scattered through the wooded part, we placed signs for the principal trees, which signs we had invented ourselves from our observation of the character of the trees. The basswood, for example, we found most numerous in the lower parts, the butternut on the ridges. The ironwoods we noticed to be small but thrifty, shade not being so detrimental to these weeds of the forest as to many other species. At the close of the school year, a little lad of eleven summers had the bright idea of presenting me with an enlarged chart of our wood, done neatly in ink. Here surely is an example of self activity.

Early last April, we spent two mornings in the woods sugar-

making. Having obtained permission to tap twenty maples in Beechwood, we bought the outfit and went to work. The first morning we tapped the trees, the boys being taught how to select the best trees and how best to tap them. The reasons for each step were elicited or suggested, science and practise going hand in hand. It was great fun for the boys to watch the sap dropping into the cans, and to see whose cans filled first—proving their owners to have made the best choice of trees or managed the tapping best.

A couple of days later, having on hand a couple of barrels of sap or its product in syrup, we went to the woods to sugar off. First we made taffy by pouring the thick syrup on the snow. Then we boiled the rest down into sugar to take home. The boys in the illustration are enjoying the fruits of their labors in the shape of taffy.



GEOLOGIZING ON PINE ISLAND.

After each of these occupations of surveying and sugar-making, which I have described, and after considerable discussion of the same, the boys wrote compositions on 'Beechwood' or 'A Valuation Survey of Beechwood' and on 'The Maple' or 'Sugar-making.' A boy can write to some purpose after such an experience.

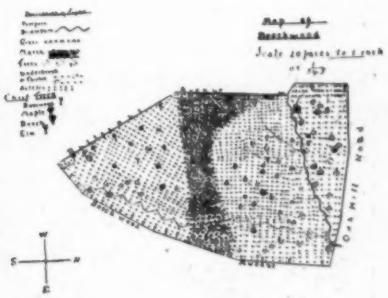
Throughout the spring the study of reviving nature was a never-failing source of delight. The boys took the keenest interest in the return of the birds, the unfolding of leaf and flower, the awakening of frog and snake, squirrel, snail, butterfly and humble-bee. We set up our aquaria and vivaria afresh. We observed the birds in their busy occupations of feeding and nesting. We sketched them in their characteristic attitudes; and learned to distinguish their varied notes and songs. We looked eagerly for the first flowers of spring, the gay hepaticas and sweet Mayflowers or trailing arbutus, and we observed

and recorded, until school closed, the lovely procession of the flowering plants. One year we observed the blooming of about two hundred of our native plants of wood, swamp and field. In this way the boys gained some conception of the wealth and variety of the Ottawa flora. We also made a special study of some one family throughout the year. I inserted glass tubes in the desks, and in these the boys were able to keep flowers fresh and beautiful. The boys also drew and painted the plants and made ornamental designs from them.*

During the spring, also, the boys went to the woods and took home trees or shrubs or flowering herbs or ferns, according to their choice, and planted them in their gardens. Just before winter set in, the boys took home herbs from the woods to have the pleasure of a bit of spring in their homes in the middle of winter. In this way we induced hepaticas and spring beauties to bloom at Christmas time, and sweet cicely a couple of months later, when the plants in the woods

THE NATURAL HISTORY OF HEMLOCK LAKE.

A VALUATION SURVEY OF BEECHWOOD.



* For an account of the manual work of the school see my article on 'Manual Training' in *Acta Victoriana* for December, 1904.

TAPPING THE MAPLES.

SUGARING OFF.

were asleep beneath a garment of snow and ice three feet thick, as we found by actual measurement.

Hitherto I have been speaking of the study of natural history. I shall now speak of the way we studied culture history: the history of man, his struggles and progress.

As the reader will have gathered, the study of nature in this school was by direct observation. Books were used, to be sure. The school library contained many books about nature, and the readers used were Wood's 'Natural History Readers.' But the books were not the center of the study; they were merely accessory.

As with natural history, so with culture history. We began by observation. To get a large view of their native place, some six outings were spent in compassing the city on foot. Practical elementary lessons in surveying and mapping to scale were given, beginning with the schoolroom. Then a map was made of the city and its environs, and the course followed in the walks indicated, as well as the topography and the important buildings and public works. Visits were paid, mostly in the winter, to various institutions: to Parliament and City Hall and Market; to the shops of the jeweler, furrier, picture dealer, florist and maker of musical instruments; to the various factories and offices to see men wrestling with resistant matter in its various forms of wood, tin, copper, iron, stone; the lumberman, the joiner, the turner, the carver, the stone molder, the mason, the bridge-builder, the diver, the blacksmith, the printer, the bookbinder. We also attended the Ottawa Valley ploughing match just before winter set in, and visited the Experimental Farm at all seasons.

Meanwhile, the history of our city and district from the days of the sturdy backwoodsman to the present was unfolded and maps were made of the county and district. The industries of the locality were studied as conditioned by its peculiar resources in soil, timber, minerals and water-power. Then the early history of the various provinces and of the Atlantic states was narrated. The gist was given (with occasional reading of the more interesting parts) of many works relating to the discovery, exploration and settlement of the various parts of the American continent by the races of Europe. A map was drawn and so marked and colored as to give a bird's-eye picture of the course of discovery and settlement. In another map the native districts of the Indian aborigines were indicated, and something was told of Indian character and legend. Here again the school library was a valuable adjunct in the work, and sometimes the boys brought from their homes books bearing upon the subject in hand.

The parents have freely expressed their appreciation of the methods of the school.

I have tried to describe the value of this natural education, yet I have scarcely touched upon one aspect—perhaps most important of all,

but too subtle to be pictured either in words or in illustrations. I mean the sweet, unconscious influences of nature and of one's native environment. By taking care that the child's associations with home are rich and full, we provide for the man an inexhaustible source of inspiration.

The reader will have observed that all that I have spoken of so far is really history—the history of nature and of man; and he will have seen how impossible it is entirely to separate these two things in any natural treatment of them. This is because they are not so much two separate things as two aspects of the same thing. Does not the reader see the application of this truth to education? Does it not suggest to him the thought that in taking his children away from nature,

STUDYING THE NATURAL HISTORY OF BEECHWOOD.

away from their natural environment, and shutting them up all day in a schoolroom, chained to desks and books, he is doing violence to all that makes boyhood precious—to its naïveté, to its love of all out-doors, to its instinctive craving for activity, and he is depriving it of the most natural means of its own development?

I wish to guard against a possible misapprehension. I am not laying down a school course for teachers. My school was situated in Ottawa, and the choice of culture material was governed largely by that fact. If I were to teach in Halifax, or Toronto, or Calgary, or Vancouver, I should deem it my first duty to study the conditions existing there. For I hold that the teacher will find in the locality, in the environment in which he lives and in which his pupils live, the most appropriate and the most educative material of instruction, far exceeding in value that found in any text-book or in all the text-books.

To the teacher, therefore, this article is purely suggestive. It is for the trained teacher who possesses independence and initiative to work out his own course. His course should grow with his growth and with his increasing knowledge of his pupils and of his environmental conditions. It should be the teacher's task to locate his locality in its relationship to the rest of the country, geologically, geographically, meteorologically, botanically, zoologically, historically, in politics, in art, in literature, in industry, in all its conditions and endeavors, showing the place it has taken and the place it is destined to take in the building up of the national spirit and character.

ON THE BOOM.

THE CAUSE, NATURE AND CONSEQUENCES OF EYESTRAIN.

By GEORGE M. GOULD, M.D.,
PHILADELPHIA.

NO questions are so often asked of the oculist by his patients as, 'Why do so many people, and even children, have to wear spectacles nowadays?' 'Are we deteriorating?' 'Are eyes so much poorer than formerly?' 'My grandfather did not wear glasses,' etc. Each oculist meets the questioning in his own way, but the public still remains unconvinced, suspects there may be some mistake about the whole matter, and is at least mystified.

It is hard to give satisfactory answers, at the best and with all one's good will. Not a little of our inability to throw light on the subject comes from our own indecisions and nonunderstandings. About many of the phases of the matter we have not reached a common conclusion and our professional differences of opinion bring further doubt to our patients. Concerning other parts we are also utterly unknowing ourselves, because the mechanics and neurologics of sensation, mentation and even of nervous force and transmission, still remain utter mysteries to all. Of these things the most learned are as ignorant as the most unlearned. We see or conclude that certain trains of ether-waves with a vibrational periodicity of some 400 to 700 trillions per second are transformed somehow into retinal and neural bundles of forces traveling only at the rate of about 125 feet per second; thence proceeding to the cortical visual center they are again transformed into what we call sensations of form, light and color. And innervational forces are sent back to the muscles of the eyeball, which move it as a whole, or modify its internal functions. Although we can know nothing of the intimate nature of these mechanisms and forces, we can deduce many definite, though crude, conclusions as to their causes and their results.

The dominating demand which governs all the processes concerned is for an accurate and accurately focussed image upon the retina of the object upon which the eye is trained. All human physiology centers in that success, and much of our pathology follows from its failure. That there shall be two such images upon 'identical points' of the two retinas only heightens and complicates the difficulty. The clearly-defined perfectly-representing image upon the retina is purely a matter of optics, physical and physiologic, and may be understood by any one who knows how his kodak takes a picture. To realize the difficulty of the kodak of the living eye, one must have an adequate conception of

the variations, only one two-hundredth or one four-hundredth of an inch from the normal in the dimensions of the eyeball or in its corneal curves which may prevent the accurate photographic 'definition' of the retinal image. To this must be added a knowledge of the means or lack of means possessed by the eye to overcome or neutralize these results of deviations from the standard of size and contour. What are the kinds of deviations that may be cancelled, how far the neutralizing is possible, what kinds may not be overcome, and the mechanism of the overcoming, these are all pretty well understood.

In the briefest way we may say that if an eyeball is too long (from the cornea to the retina) it is near-sighted or myopic. One can not see well at a distance, for everything appears blurred and hazy. The focus of the image is in front of the retina, and there is no device of the unaided eye which can transpose it to its proper position upon the retina. Any effort to do so is by the nature of the conditions a negative one, an endeavor, if one may so speak, and of course, unconsciously, to lessen muscular effort. There is as result no eyestrain, no morbid, or wearying, or hurtful attempt at muscular exertion.

The supposition, in this case, is that a pure or uncomplicated myopia exists, and that it is of the same degree or amount in both eyes. In truth, however, that supposed condition never exists. No oculist probably ever tested a pair of eyes having no astigmatism, and having exactly the same over-length, or myopia. And this astigmatism, or the difference in lengths of the two eyeballs, or both factors combined, brings always the possibility of 'eyestrain.' For eyestrain is the name given to any unphysiologic, *i. e.*, pathologic ocular action or function which is wearying, excessive or unnatural. It thus becomes clear how it is that the two eyes by reason of the presence of a difference in their relative lengths, or because of astigmatism in one or both, may result in morbid effort or strain, although if both were alike in over-length, and without other optical defect, there could be no such strain. This general fact makes evident the truth that in general those with (moderately) myopic eyes have far less ocular diseases and pains in the eyes, less headaches and other general disorders, than those whose eyes are hyperopic, or 'far-sighted.' For in all 'far-sighted' eyes there is a never-to-be-renounced effort to overcome the trouble. But this freedom from pain and other symptoms in myopia may lull the patient with a false security and costly neglect. The great danger is that without the attention of a skilled specialist the myopia may increase, become 'malignant,' as it is termed, and the eyeball continue to elongate, with imperilled or fatal loss of vision. The myopic eye is one abnormally elongated, enlarged or stretched, and once having lost its tonicity or normal measurement, it tends to extremes of enlarging.

The far-sighted or hyperopic eye is the reverse of the myopic eye:

it is too small or too short and hence effort and muscular exertion are necessary to bring the image forward, in proper definition upon the retina. Without this exertion the image would be behind the retina. Hence a similar blurring or badly defined picture as in myopia, but from the reversed cause. In this kind of eye the picture is naturally blurred even of the most distant object (making the term far-sightedness a misnomer), and a slight increase of focussing power is required on the part of the 'accommodation' mechanism in each eye, in order to shorten the focus of the image-forming rays of light. With every lessening of the distance of the object, still greater converging power is demanded, as one may understand by tests with different-power glass lenses. When the object is brought within ten or fifteen inches of the eye the greatest effort is required to make the image clear. The degree of this effort will depend upon how much too short the eyeball is, or upon the amount of hyperopia. It will also depend upon the kind and amount of ocular labor, especially the continuance of 'near-work,' the reading, writing, etc., required of the eyes. The farmer, ranchman or sailor will obviously be able to overcome or be indifferent to higher degrees of far-sightedness than those living in cities, while the literary man, bookkeeper or seamstress will experience eyestrain with still lower degrees of hyperopia.

One must carry in the mind another modifying condition—the difference almost always existing between the far-sightedness of one eye and that of its fellow. The two are under more stringent orders than in myopia to work together and in harmony. When the hyperopia differs in the two the chances of strain are obviously increased many times.

These chances already multiplied now become inevitables if astigmatism is a complication of the hyperopia. Alas, also, it is very certain to complicate. I have measured something like ten thousand pairs of eyes, and not one of these pairs was without some imperfection of shape, size or curvature, either in one or both of the eyes. An absolutely perfect pair of eyes does not probably exist.

'And do tell me, what is astigmatism?' is the puzzling question put to the oculist every day. It is one, fortunately, very simply and easily answered. The front part of the eye, that behind which lies the pupil, is called the cornea. It should be round or equally curved like the central portion of the end of an egg. It is usually not uniform in its curvature, but is more curved in one meridian than in the reverse meridian—that is, it is, approximately, of the shape of the side of the egg. When symmetrically curved it will naturally refract, or help to focus, correctly, the entering cone of light which is to form the picture on the retina. If it is unsymmetrically curved, like the side of the egg, it will produce a misshapen and unsymmetrical picture which does not accurately represent the object. The condition of safety,

right movement and proper 'senseing' of the world thus depends upon the exactness of this image-making power of the eye. It seems probable, indeed, that one of the greatest factors in the survival of the fittest or in the elimination of the unfit, in biologic and social evolution, has been this overlooked optical inaccuracy of the eye. In the chase, in battle, in games, in all tribal and industrial competitions and tasks, the imperfectly-seeing must have gone down before those whose eyes saw more perfectly and whose answering hand and foot executed the precedent ocular command more speedily and precisely.

The malcurvature, or astigmatism, of the eye, may obviously be of widely varying degrees, and may be placed in any possible one of the 180 degrees of its half-circle. So infinite are the permutations of these amounts and placings, and so complicated may astigmatism be with any kinds of short-sightedness or long-sightedness that, as emphasized, in all probability no one eye in the world has identically the same optical measurements and powers as another. No pair is without optical imperfections and none has exactly the same ones as those of any other. The chief and continuous cause of astigmatism is the pressure of the upper lid upon the cornea just at the upper edge of the pupil. The astigmatism in the vast majority of all eyes shows that the cornea is curved more in its approximately vertical than in its horizontal meridian. The few cases in which this kind of curvature is not present are really 'exceptions which test the rule.' The habitual placing of the upper lid at this precise line of the cornea is caused by the necessity of shading the cornea or protecting it from the light which would enter from above and dazzle or harm the delicate retina. Every one when facing a bright light has found how bad vision is for at least some minutes afterwards. This semi-paralysis of retinal function would make activity slow and inconsequent, if not often jeopardize life. It has been a helpful factor during the evolutionary struggle in preserving the organism.

A study of the position of the upper eyelid and coordinated pupillary movements in animals would show each type meeting or avoiding the difficulty by many devices. In such animals as fishes, birds, owls and many forest-roving animals there is danger from above as well as below, so the upper lid is kept well retracted and the pupil wide open. In the owl the pupil is large even in daylight, and hence this bird is then in a dazed condition of mind, and flight is dangerous. The mechanisms designed to give definition to the retinal image, to shade the retina so that it may recuperate its sensibility for the next instant's instantaneous image, accentuate the fact that the formation of the retina was perhaps the most difficult task encountered in the development of higher forms of life on the globe. All organic success depended upon that special success.

And few have the most dim notion of the complexity of the organ of vision in man, or of the amazing difficulties of 'Biologos' in fashioning and perfecting it. Millions of finger tips are bunched together in the one-inch cup of the eyeball, from whence run about 425,000 nerve fibrils to a topographic mechanism of sensation in the occipital lobe. The eye can see an object 1/1,000 of an inch in diameter. The cones and rods are only 1/10,000 or 1/14,000 of an inch in diameter, and a million cones at the macula occupy a space of only 1/10 of an inch square. These crowded finger tips perceive the shape of the picture and the intensities of the light stimuli of all illuminated objects, of a millionth of a millionth of the kinetic power of any other physiologic force, and of so short a duration as the 0.00144 of a second. And out of these infinitesimal waves the sensations called light and color are created. The mechanism which creates them must be in intimate and instant connection with the centers initiating and controlling every other sensation, of every motion, of every muscle of the body. Imagine for an instant what takes place in every animal and human being every day of its existence: *e. g.*, a traveler tells of a monkey pursued by another, and running over and through the tops of the trees of an African forest faster than a deer could run on open ground. The flashing repetitive momentary glances of the eyes, before, back and all about a hundred objects must be coordinated with a mathematical precision to accurate unity and brilliant action of every muscle of the body. Similar perfection of eye and motion has been evolved in every higher animal of the world, and in every savage, and in every child. In man there is no danger from above, the eyes are rarely raised to the sky; the pupil consequently has a wide range of movement, and to shade the pupil the lid drops to its upper border. Doubtless we possess a more appropriate color sense, retinal discrimination and visual judgment because of the device.

The need of a shading of the retina to produce clear and quick imaging, 'resensitizing of the visual purple' it has been called, is so great that there are distinguishable a surprising number of separately-acting mechanisms, all working to this end:

1. The shadows cast by the retinal arteries, veins and capillaries.
2. Reflections and shadings from the individual corpuscles of the blood in these vessels.
3. The shadings of vitreous cells called *muscæ volitantes*.
4. The pigmentary layer of the front part of the retina continuous with that of the iris.
5. The iris-pigmentation, lack of which constitutes the tragedy of albinism.
6. The continuous narrowing and widening of the pupil.
7. The pigmentation of the skin of the lid, and the comparative opacity of the lid-structure itself.
8. The eye-lashes have an additional screening function, while allowing vision or suggestion of an object above.

9. Winking shades the retina entirely every few seconds of the waking life.

10. The possession of two eyes with their associated movements constantly varies the light-stimulus, shading, etc., more than would be the case in a cyclopean eye.

11. Incessant movement of the eyes accomplishes the same object. Looked at steadily an object is lost from view, especially if it be brightly illuminated.

12. The eyebrow serves as a shading device. In old men, when the retinal sensibility is dulled, and more slowly recuperated than in youth, the eye-brow hairs often take on a luxuriant growth.

13. The retraction of the eyeball, by the absorption of the orbital fat, especially in the aged, serves in the same way toward additional shading.

14. The habitual position of the upper lid across the upper edge of the pupil works clearly to the same end. It is so necessary that it must be allowed although it brings with it a new source of evil.

For with this pressure of the lid comes astigmatism—one of the greatest causes of suffering in all civilized societies. There is probably little or no astigmatism in the eyes of those animals whose lids are habitually retracted—'wide open,' as the birds, fishes and many of the mammalia. The outward pressure of the fluids within the eyeball tends to keep the cornea taut and symmetrically curved.

The 'accommodation' function of our eyes is their power to focus equally clearly the images of objects at a distance and those near the face. Its mechanism is the crystalline lens, controlled by the ciliary muscle. The lens has an innate and spontaneous elasticity which gives it the ability to increase its refractive power required as an object is brought nearer the eye. This increased refraction is incited by the contraction of the ciliary muscle. This act is called accommodation. As has been said, it is little exercised in myopia, and hence there is little pain or 'eyestrain' in purely myopic defects. In the condition called emmetropia, or optical normality (only approximately existing), it is called into use, and increasingly with every increase of nearness of the object looked at, until its extreme is reached when the object is so near the eyes that it is not clearly seen, that is, with accurate focus, or clear photographic definition.

With this point reached in our exposition we come upon the heart of the matter, which is this: In the ages of past evolution the safety of the organism has depended upon sharp distant vision—the more or less distant, from the horizon to a few feet from the eyes. The mechanism of accommodation has been evolved in answer to this need. The nearer an object the less continuously must accommodation act, the less uninterruptedly was the contraction of the ciliary muscle. The extreme of muscle tension or contraction, the full force of its innervation can only be carried out for the shortest periods of time. That is the great law which dominates the action of every muscle of the body. If its contraction is kept up continuously for too long a period the result is not only weariness, but spasm, exhaustion, pain, disease, etc., and physiology passes into pathology. Carefully analyzed there

will be found no muscle in the body which can endure continuous contraction except for a short time. Tests of holding the arm out straight, carrying a light satchel in one hand, etc., are familiar. Most muscles called into continuous action show that the continuity is an interrupted one, and that there are necessary rhythms of contraction, relaxation and rest. The genius of evolution, so far as the eye is concerned, never foresaw the demands to be made upon the organ by our modern life. In but one or two hundred years since printing, urbanization, commerce and the rest have sprung into existence, the entire process, ocularly speaking, has been reversed; before this it was an intermittent and temporary function, while that of reading, writing, sewing and handicrafts demands a focussing of the image of objects at twelve or fifteen inches from the eye; this for millions has now become a continuous one. For all hyperopic and astigmatic eyes the act of accommodation is required for ten or fifteen hours a day, often for hours with hardly a moment's interruption. This unwonted demand requires the continuous innervation and contraction of the ciliary muscle. To comply necessitates an impossible task, considered physiologically; the result is eyestrain with its host of sequent diseases, far-away reflexes, headaches, nervous diseases and kinds of ill-health too numerous to enumerate.

If the hyperopia were alone present, and especially if the amount were alike in each of the two eyes, cerebral ingenuity could cope with it with far less disastrous results than are everywhere shown. The eyes are seldom alike and the evils multiply. But they become genuinely morbid with the complication of the usually-present astigmatism.

The ciliary muscle is a 'sphincter muscle,' fashioned in a circular manner about a central point, and by its very nature it must act by an equal, or comparatively equal, contraction of all its parts. Astigmatism is a defect acting in a line across the structure, and hence to neutralize or compensate, the ciliary muscle is called to act against its structure and nature upon two opposite sides, those parts at right angles not acting. Hence the impossibility of overcoming the defect, at least in but a limited and partial, and always unnatural, way. The higher the astigmatism the greater the limitation and impossibility. In the high degrees it is frankly out of the question, and the retinal together with the sensation-making function is hurt by the false and blurred image, and vision deteriorated. 'The old ophthalmology,' still ruling unquestioned in Europe and largely everywhere, looks upon the correction of astigmatism by glasses only as a means of giving better vision, and so corrects only the large errors. It forgets that in these large optical defects the ciliary muscle renounces effort, and that the smaller ones are precisely those which produce the worst morbid results, because the strain of accommodation, or continuous

contraction of the ciliary muscle, can never be renounced. This constitutes the predominant source of eyestrain.

There are several other misfortunes or imperfections of the accommodation mechanism which may not be neglected if we wish to understand the matter in all its bearings. The crystalline lens must of course be transparent, hence it can not be nourished directly by the blood with its red corpuscles. Its healthful action is, therefore, dependent upon nourishment by blood-serum alone—plainly a difficult task, especially as this serum must reach it indirectly by osmosis, filtration, etc. It has also no nervous connection with the brain, and the three conditions named conspire to bring about two most noteworthy faults in its life-history. It is prone to become non-transparent or opalescent and, finally, almost opaque in the old, and this is cataract. Its elasticity also decreases steadily from childhood until it is so inelastic at about 45 years of age that the 'range' or degree of accommodation becomes too limited to enable it to focus the images of objects clearly on the retina except by holding the book, for instance, too far from the eye. This is the beginning of 'presbyopia'; at about sixty all the elasticity of the lens is lost and accommodation is at an end. Moreover, oculists have been hitherto unmindful of the fact that the accommodation may be less than normal in many young patients, even for short tasks. It is always so for long and continuous ones. For presbyopia, there is no prevention and no cure. There is a makeshift device (spectacles) whereby we may supply the lost focusing power of the living lens, by glass lenses placed in front of the crippled 'crystalline lens.' Of cataract, however, there is a pretty sure method of prevention, and this, again, is spectacles.

The science and art of correcting or neutralizing these optical defects of the eyes—myopia, hyperopia and astigmatism—is by means of artificial optical lenses. First, be it noted, it is a medical art and science, which no optician can compass. He has neither the legal nor the ethical right to attempt it, and surely he has not the scientific and medical knowledge requisite for its accomplishing. However poorly the medical man has executed his task, the optician will do it far more blunderingly. This *verbum sapienti* should be sufficient warning until, as with the druggist, we have also with the optician, passed laws to prevent him from attempting to fill the office of physician. There will then not be so many ruined eyes, and far less suffering from eyestrain.

Spectacle lenses have the power of changing the shape and direction of the image-forming cone or bundle of rays of light entering the eye so that its faulty optical construction and powers are neutralized, and the image is at last accurately focussed, and perfectly pictures the object. The outside lenses are in a way reversely unnatural, so that the inner eye-defect is met with an outer cancelling modification,

whereby the direction of the parts of the rays making the image are so modified as to restore the picture about to be formed to normality. Plus is met by minus, minus by plus, astigmatic one-sidedness by its reverse. If the living eye were a dead mechanical one, if it were not subject to many diseases, if the results of eyestrain did not end in a multitude of diseases of the entire body and mind, then the optician might learn to prescribe glasses. But even for the highest medical intellect the work is a science and art demanding his best powers. Some one said that there are nine and forty distinct and separate ways of achieving damnation, while there is but one of salvation. There are twice that number of separate ways of failing to get right spectacles, and seventy-eight of them are set forth by an American oculist, reasons being given why, if any one is neglected, there will be no relief of eyestrain. Even if the physician's prescription is right, even if the lenses are properly ground and mounted, even if the spectacles are properly adjusted to the wearer's peculiarities of face, etc.—and these are all hazardous suppositions—there remains the wearer's carelessness, prejudices and ignorances, to thwart the entire proceeding. There are microscopists, and astronomers who will spend lifetimes of self and others, in care to correct the optical inaccuracies of their microscopes and telescopes, and yet whose own eyes that look through the instruments have far more glaring optical defects than Clark eliminated from his objectives by years of patient labor. The eye that sees everything can not see itself. So slow is man to study the student, himself. He will even investigate the brain and its functions before he will the eye: although embryology demonstrates that it was the brain which developmentally came out to see; the eye did not at first exist apart from the brain, and then send in to the mind the message of its discoveries. When once the million threads of brain substance were pushed out to the surface, the product called intellect resulted. For all useful thinking is in visual terms, and the *sine qua non* of civilization, the alphabet, is only a series of conventionalized pictures of things seen. The problem of our being here, the primal conditions of organic and social evolution, have depended and will always depend upon visual function. Is it then to be wondered at that our difficulties, bodily and social, our diseases, imperfections, our wants, failures and miseries, most frequently have also their source in visual difficulties and imperfections? Error is the softest and best word we have for human failure to reach the best attainable aims and ideals. It is more than an accident that the technical name for the great mass of ocular woes, and for the causes of multitudes of others, is 'errors of refraction.' The compulsion of fate as well as an error of evolution has brought it about that the unaided eye must persistently struggle against the astonishing difficulties and errors inevitable in its structure, function and circumstance. This struggle wrecks health, happiness and life, because by no device can the

brain steadily innervate a muscle to continuous contraction. There results eyestrain—an error, the result of an error, the consequence of an older error; all may be done away with by an easily-obtained, at present usually unobtainable, device. The obtaining of that device is a matter of more importance to civilization than all the universities and wars of the last century. 'Exaggeration?' Not so!

For what are the consequences of eyestrain? Wherever there is eye-labor 'at near-range,' as in reading, writing, sewing, mechanics, art, science, commerce, etc., there, beyond question in one half the workers, is eyestrain of a disease-producing kind. What kinds of diseases?

Firstly, those of the eye itself, for surely all good oculists agree that a large majority of local eye-diseases are themselves directly or indirectly due to eyestrain. The only exceptions are albinism, loss of accommodation generally (presbyopia), some tumors and a few minor affections. Cataract, it is being recognized, is due to the morbid function of denutrition set up by the strain to neutralize errors of refraction, and may be prevented by wearing correcting spectacles long prior to the 'cataract age.' Almost all other inflammations of the eye, not excepting often the infectious ones, are usually due to the same morbid function. Function, as all good physiologists know, always precedes structure, and malfunction, as all good physicians know, also precedes the morbid and fatal organic pathology. Eyestrain is almost always the cause of eyes turning in, or out, that is, squint or strabismus, a trouble that is 'innervational in nature and refractional in origin.'

The next of the series of bad results of eyestrain are cerebral. The brain comes out to see, but owing to the enormous difficulty of the task, it sees poorly and with exhausting or irritating labor. As its every process and act is bound up with and the product of vision, visual disorders by reflex and passed-on malfunction induce cerebral affections, evidenced primarily by headache, migraine, etc. Although the medical text-books give little or no hint of this, it is true, as thousands of good physicians and patients well know, that headaches, ninety per cent. at least, are due to eyestrain. Many observant physicians believe that the so-called 'paroxysmal neuroses,' periodic headaches, migraine, epilepsy, asthma, etc., as well as hysteria, neurasthenia, 'brain-fag,' 'nervous breakdown' are very frequently caused by years of morbid ocular struggle.

Mental diseases follow: weariness, alternating with hyperexcitability, an amazing need of walking, truancy (escaping from ocular labor), morbid introspection, nameless torments and self-tormentings, diseased habits, hopelessness, melancholia, manias, incipient and functional insanities and indirectly occupational failure, crime and many other errant trends.

The methods by which morbid ocular function induce various bodily

diseases are so varied, differing almost in each individual, that it is impossible to set them forth in detail. Primarily it seems certain that the process is essentially one of waste and exhaustion of nervous force; all corporeal activities depend upon right-seeing. All subordinate cerebral centers are drawn upon to restore the balance when clear and easy seeing drains too severely the optical store-houses and regulating mechanisms. But the peculiarity of nervous action is that often undersupply and even exhaustion ends in irritation and excessive nerve action. Hence we find hyperesthesia attending or consequent upon lowered vitalities and tensions. But at least and always come disordered functions and these naturally form two types or proceed by two routes. The first disorders, often the more distinctive cerebral incoordinations, are those classed as nutritional or digestional. Certainly one half of all sufferers from eyestrain have dyspepsia of some kind. 'Liver,' 'stomach,' loss of digestive power, loss or fickleness of appetite, are the complaints that constantly occur in the biographies of great literary workers, and of the majority of our patients.

The second class comprises those whose blood-supply and tension is morbidized—the so-called 'vasomotor' cases. Skin-affections, as was long ago found, are often due to 'migraine,' and migraine, we now know, is due to eyestrain. It is remarkable how often diseases of the kidneys have been preceded by years of suffering from eyestrain. Secondarily almost any affections, even surgical diseases, may supervene, caused by the lowered nutrition, disordered blood-supply or the derouted nerve influences. The terminal diseases, as they are called, because they perform the final act of killing, are often but the executioners of long precedent eyestrain. Even the infectious diseases find their best soil—and soil is as important as seed—in the lowered vitality following years of headache, dyspepsia, etc. By careful count and trustworthy statistics 27 per cent. of school children have lateral spinal curvature. This astounding source of sickness and invalidism, directly or indirectly, is due to ocular defects, functions and laws.

And if the child is father to the man, let us add, and to the woman, what a havoc of the future generation we have been preparing by our neglect of the care of children's eyes! Take it only in the aspect of a saving of time. The results of Dr. Baker's examination of the eyes of the Cleveland, Ohio, school children show that those with defective eyes are six or seven months older than the others of the same grade and that one in four have eyes that keep them behind in their studies. In the last few years the examination of the eyes and health of school children shows an appalling condition which fully bears out all that oculists have been warning against. The examiners in Quincy, Mass., state:

> Many school children who appear dull and inattentive, who are nervous, irritable, morose or disorderly, who suffer from headache, dizziness, nausea or

pains in the eyes, owe these ills largely or wholly to such defects. Generally neither they nor their parents nor their teachers are aware of the cause of their troubles. The examination of hundreds of thousands of school children has demonstrated that from twenty-five to thirty-five per cent. of them need the services of an oculist or of an aurist or of both; these handicaps can be removed and the children be able to receive the full benefits of instruction. In Utica, New York, an examination of over 6,000 pupils showed that about thirty-five per cent. were defective, and the report says "Our tests revealed many sad and critical cases which were remediable because discovered at this stage of development. Many parents could not strongly enough express their gratitude to the teachers. Cases of what had been considered dullness or willful inattention on the part of pupils were shown to have been due to inability to see or hear." In Chicago it was found that on entering school at the age of six years thirty-two per cent. of the pupils had defective eyes. In the schools thirty-seven per cent. of the girls and thirty-two per cent. of the boys, or an average of thirty-five per cent., were defective and these tests were made by an expert. In Minneapolis out of 25,696 pupils examined 8,166, or thirty-two per cent., had defective eyesight. Similar conditions differing only in degree, have been found wherever tests have been made.

In New York City Dr. Cronin finds that over 30 per cent. of the school children are suffering from the gross forms of defective eyesight. It must be remembered that the worst defects are not included in these statistics.

Lastly, the greatest of the misfortunes which may be traced to this cause are those connected with intellectual progress, the literary workers being those who suffer most. In direct and indirect ways the advances of civilization are most frequently conditioned upon use of the eyes in writing and reading. Certainly one half or more of the great writers and thinkers of the world have had their lives turned into tragedies of personal affliction by this unsuspected cause. The biographies of Swift, Nietzsche, Parkman, George Eliot, the Carlyles, Whittier, Darwin, Wagner, Taine, Symonds, Heine, De Quincey, Huxley, Lewes, Margaret Fuller, Jules Verne, de Maupassant, Balzac, Berlioz and many others are filled with pathetic evidences of the truth. It is noteworthy that in the monumental 'Life of Wagner,' Dr. Ellis, who is at once physician, musician and biographer, after exhaustive research, confirms the theory that eyestrain was the chief cause of the poignant physical sufferings of that great genius. And what influences such afflictions have on the character of the men and of their works only the discerning can surmise. The large majority of the men and women mentioned above have a striking likeness as regards a certain harshness, even bitterness, and a peculiar and pitiless insistence on logical distinctions; all but one or two were pessimistic and unreligious. Only art saved Wagner from an acerbity and skepticism, illustrated by his enemy-friend Nietzsche and his philosopher, Schopenhauer. It does not require a great mind to recognize the profound influence of disease upon character and philosophy.

THE STATUS OF AMERICAN COLLEGE PROFESSORS ONCE MORE.

By Professor JOHN J. STEVENSON,

NEW YORK UNIVERSITY.

ABOUT a year ago, the writer discussed some matters bearing upon the condition of college instructors in America. A restatement of some parts of that discussion is necessary, as events occurring during the interval have tended to divert attention from the more important issues.

An impression seems to prevail that the Carnegie foundation has rendered unnecessary further discussion of the salary question. But the provisions of that trust, perhaps intentionally, are such as to provoke further discussion, for the salary accorded to emeritus professors is to be in direct relation to that received prior to retirement. As the payments will be only to men of sixty-five years and upward, they will affect at best only a few years at the close of a long period of service, and in all probability, they will be of personal interest to a very small proportion of the whole number of college instructors.

The writer has been criticized for laying stress on the matter of salary and for thus introducing a mercenary feature which is degrading to the profession. But education is no longer in charge of ecclesiastics pledged to lifelong celibacy, and theoretically at least, to lifelong poverty. The notion that teachers should be indifferent to pecuniary matters is a survival, which still holds in the minds of some youthful students and occasionally gains control of a college trustee, but it has never found favor among tradesmen. While it is true that no man should become a college instructor merely to gain a livelihood, it is equally true that the matter of income should not be ignored, for in our day one is hardly to be commended for choosing a profession in which poverty or the observance of the strictest economy must be his lot through life—provided always that he is fit for anything else. And this is what makes the question of salary so important from the standpoint of the college. Statistics show that in the leading eastern institutions and in the leading state universities the average salary of professors is about 2,000 dollars; but this is the salary of a full professor and is the maximum which most men may hope to receive after years of service. Such being the case one must recognize the danger tc which colleges are exposed especially on the side of pure science, which for educational purposes is the more important.

To the greater number of those who have become teachers of science in our colleges, the chief attraction has been the promise of leisure for study. But in the greater number of our institutions, that leisure has practically disappeared and young men recognize the fact. On the other hand, the applications of pure science have been multiplied; the chemist, physicist, geologist and biologist have become, each of them, the mainstay of industries not only requiring many millions of capital, but also contributing in equal proportion to the welfare of mankind. In each of these industries competition is so earnest that incessant investigation along lines of pure science is essential. There is here promised a greater reward of fame than the college instructor can hope for, while in addition there is a prospect of pecuniary reward for the wise and industrious man, compared with which the maximum college salary is a pittance. It is quite in accord with human nature that young men after completing graduate study, costly both in time and money, should think applied science, which promises both fame and money, preferable to college teaching, which promises in our day not very much of either.

It has been said that a change has passed over the minds of American college professors, that, whereas formerly they regarded investigation as the all-important and teaching as the unimportant part of their duties, they now regard themselves as chosen especially to teach. This is a somewhat belated discovery, for the American college professor has always been preeminently a teacher, to whom investigation has always been, as it were, a side-issue. But for a generation, owing to rapid expansion of curricula without corresponding increase in number of teachers, there has been an increasing neglect of investigation. For the most part, small colleges to-day are as well off for men and equipment as not a few of our larger institutions were fifty years ago, but their contributions to the sum of human knowledge, at least on the scientific side, are in no sense comparable with those made by college men of the earlier period. This reacts on the college, for men who are not investigators by nature and to some extent, at least, in practise can never be genuine teachers. They may be good disciplinarians, masters in the art of hearing recitations, adepts in compelling students to learn lessons, but as retailers of merely second-hand information they never can be makers of men.

Beyond all doubt there will always be an ample supply of candidates, whatever the salary may be, but ambitious young men will not take up a profession which threatens to dwarf them intellectually and socially; rather will they turn aside to business or to other professions in which great prizes await diligence and common sense. The sentimental grounds on which many chose college work no longer exist, since opportunities for service to others abound everywhere even for the busiest

of men. Such opportunities were rare formerly and, for their sake, college work was chosen by many to whom pecuniary reward was, in comparison, a secondary matter. And this led in no small degree to the high esteem in which college professors were held, for the corporate boards were composed chiefly of professional men, who believed that they had chosen their work for similar reasons. But the boards of to-day are made up largely of men of affairs, strong men of the business world, who are apt to regard indifference to material success as evidence of native weakness.

While the matter of salary is important in its bearing on the future of American colleges, it is of less immediate importance than that of relations between the teaching and the corporate board. This is the vital matter.

Theoretically, the corporate board of to-day and the college president of to-day are the same as they were one hundred years ago; but in fact they are essentially different. The boards and presidents of the former days were so familiar with the conditions of their little schools and of the narrow curriculum that they were competent to take charge of them. To-day the curriculum is so broad that neither board nor president can be familiar with the needs of the several chairs even in institutions of moderate size, while in universities it is barely possible for them to have any personal knowledge whatever. Yet the teaching board is wholly subordinate to the corporate board. Such complete legal subordination was well enough as long as the chief purpose of colleges was to prepare men for the ministry and subordination may be well enough still in purely denominational colleges, whence it is fit and wise to eject summarily those 'courageous, independent thinkers' who would hold to their salaries while rejecting denominational tenets; but the university has outgrown the swaddling clothes of the semi-theological college and the method of control should be adapted to the new conditions.

It is well understood that the corporate board as a rule is not composed of men familiar with educational matters. The rapidly increasing financial interests of colleges and universities necessitate the selection of men possessing thorough business ability. Examination of college catalogues shows that the boards are made up chiefly of men beyond middle age, eminent lawyers, prominent business men, with some clergymen and physicians, all of highest standing; all of these are busy men, whose prominence proves that for many years they have been engrossed in the work of their several callings so intensely as to be disqualified for some of the duties devolving upon college trustees; most of them are far removed in thought and occupation from educational work and few of them are in any degree familiar with the changes in scope and methods of college teaching. Nor, as

has been said elsewhere, have they opportunity to acquire the necessary familiarity after assuming office, for business matters occupy most of the time at board meetings and matters affecting work by the teaching board are largely incidental. It would be strange if the trustee did not regard his board's responsibility as the more important.

The change for the worse in relations of the boards is due in no small degree to a change in character of the president's duties. That officer is no longer primarily a teacher; in many of the larger universities he does no teaching, is simply the executive officer; while in many of the smaller institutions he does little teaching because efforts to raise money occupy most of his attention. The chronic impecuniosity of most colleges prevents trustees, when seeking a president, from inquiring closely respecting a candidate's fitness to represent the educational side of the institution; money and more students are the crying needs. The appointee is usually a man of great expectations—on the board's part; he will find money, gather students, advertise the institution, awaken interest everywhere and convert indifferent alumni into hustling canvassers. But once appointed he is left practically to his own resources, to be praised by the board if he succeed, to be blamed if he fail—a rather uninviting post, whose holder deserves more sympathy than is contained in the libel that he has every grace except that of resignation. He has been appointed not to elevate the institution as an educational power, but to make of it a 'big thing.' One may not censure him severely for emphasizing what may be termed the non-educational side or for resorting at times to odd expedients for increasing the total of students and instructors; but the results have been disastrous, for thus it has come about that the vast majority of people and the vast majority of prospective students measure an institution not by the character of its instruction or by the fitness of its instructors, but by the mass of its buildings, by the number of students and by its prominence in the semi-professional athletics which so disgrace American colleges.

The president is practically the only source whence the trustees may obtain information respecting internal affairs of the institution, as, with rare exceptions, the faculties have no representatives on or before the corporate board. He is the responsible head, the only element known to the trustees; in the nature of the case, he formulates the business to be presented, so that, if he possess a fair degree of tact, the board merely carries out his wishes. If successful in securing money and students, he is liable to be human enough to forget that he has done this work as the professors have done theirs and to think of himself as creator with consequent right to control policy and to direct expenditure. Business presented to the trustees is not likely to be such as to encourage great inquisitiveness respecting details of internal

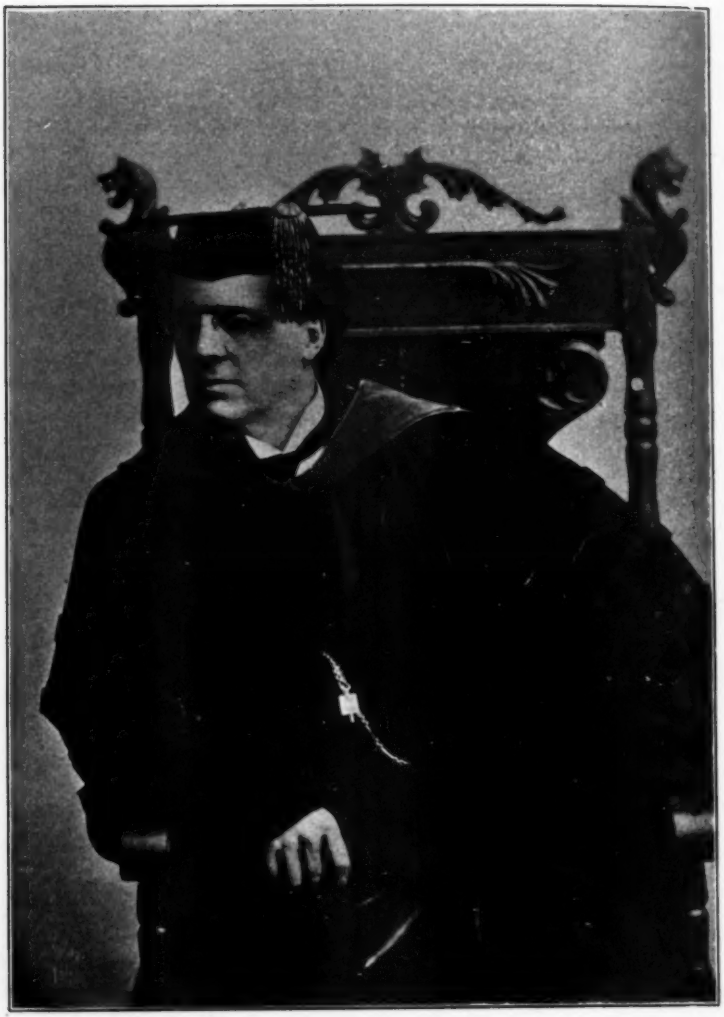
affairs. And all this is thoroughly compatible with a strict sense of honor and with conscientious devotion to what he believes to be the best interests of the institution. But the result is unfortunate. The executive duties of his office render the president less and less fitted as the years go by to represent the purely educational side of the institution, yet every year strengthens his control of all the interests. This condition is not in accord with business common sense.

If the proper status of the faculties is to be restored, and if the proper standard of educational efficiency is to be regained, there must be a radical change in relations of the teaching and corporate boards. In church organizations, the religious interests are ordinarily in care of one board and the secular interests in care of another; but the former, being charged with the interests for which the church was organized, is superior to the latter, although this represents the corporate body before the law. A similar grouping and relation should exist in educational organizations. The trustees should not control in any degree the internal affairs of the college or university, their duty being to relieve the teaching board from the burden of caring for business matters and to represent the institution before the state. They should fill vacancies in their number, subject to veto by, say, two thirds vote of the full professors; but the faculties should have complete control of all matters relating to the actual work of the institution and they should make all appointments to the teaching staff, subject to merely *pro forma* confirmation by the trustees, as representing the corporate body, or to veto by them in case there are not funds to warrant the expenditure. The office of college president, as it now exists, should be abolished; each faculty in a university or the single faculty in a college should choose its own executive head, who should be simply *primus inter pares* and should be the mouthpiece of his faculty in conference with other faculties or with the trustees. In a university, the several executives would be a council to determine matters affecting the policy of the institution as a whole.

Some appear to dread such reconstruction as liable to bar all progress, for it has been said that, somewhere, the most important advances have been made in face of earnest opposition by professors. Possibly. But it may be that some steps, advances in the opinion of a president, might be retrogression in the opinion of an educator. The dread, however, is unnecessary in view of the fact that the remarkable elevation of standard in legal and medical education within the last twenty years is due wholly to the professors themselves and largely, in most cases, at their expense. This statement is equally true of schools of applied science and it is well understood that in colleges the professors constantly struggle for maintenance of high standards. More than this. Professors have been known to show themselves capable of attending

to the business affairs of their institution; have been known indeed to take up the burden of business, after it had been abandoned by the corporate board, and so to care for teaching and business that in time both were returned in excellent condition to the control of the trustees.

No doubt it is true that in some cases the faculty gathered under the present system may not be fully competent to undertake management such as has been suggested; but that is no reason for continuance of a system which can bring about such a condition. Serious errors are less likely to be made by those who know something about the requirements than by those who know very little or practically nothing about them. A not very skillful carpenter is a far better judge of carpentry than the ablest statesman can be. A faculty of not very high grade can judge better respecting the all-around fitness of a candidate than can a board composed of eminently successful bankers, lawyers and clergymen—better even than can a college president, who at one time was a typically good professor, but who by force of circumstances has been diverted from educational work to become a strong man of business.

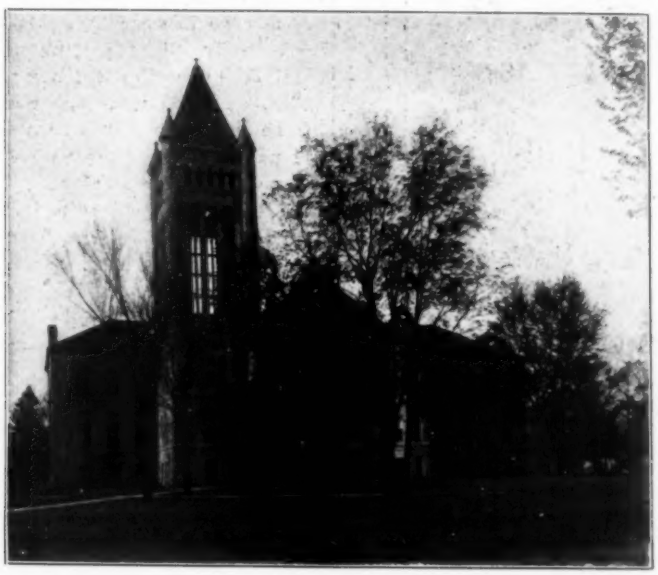


President Edmund Janes James.

THE PROGRESS OF SCIENCE.

THE INSTALLATION OF PRESIDENT JAMES AND THE UNIVERSITY OF ILLINOIS.

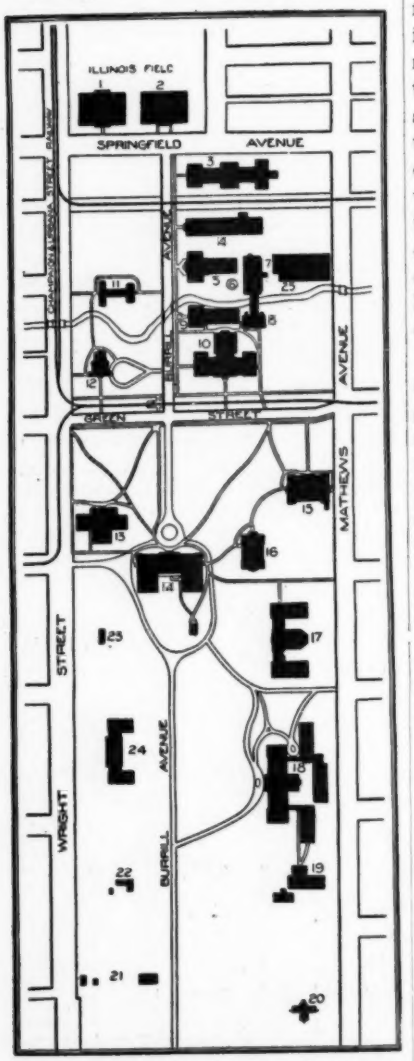
THE installation of Dr. Edmund Janes James as president of the University of Illinois, on October 18, gave occasion for an academic celebration of more than usual magnitude and significance. The exercises were extended over the greater part of a week, and delegates were in attendance from about two hundred colleges and universities. There were religious services on Sunday, October 15. On Monday the Women's Building, a view of which is shown below, was dedicated, and in the evening the university address was given by the Rev. Frank W. Gunsaulus, of the Armour Institute. On Tuesday there was in the morning a discussion on the 'State and Education,' and in the afternoon the National Conference of University Trustees began their sessions. These sessions were continued on Thursday, and at the same time there was a Conference on Religious Education in State Universities and Colleges, and a Conference on Commercial Education, which was continued on Friday. There were in the meanwhile assemblages of the various colleges, the presentation by students of Robert Greene's Friar Bacon and Friar Bungay and other arrangements. The formal inaugural exercises were on Wednesday. In the morning there was a reception of delegates with a roll call of the universities and responses by selected delegates. In the afternoon there were addresses by the Governor of Illinois, the president of the board of trustees and Dr. Andrew S. Draper, former president of the university, followed by the inaugural address of



LIBRARY BUILDING.

President James and the conferring of degrees.

Some part of the ceremony, such as processions in cap and gown, the formal reception of delegates with the presentation of Latin addresses and the conferring of degrees, may be more in place in an English university, where the medieval tradition has been continuous, than at the center of the population of a democratic nation. The conventional academic ceremonial has, however, certain advantages in a somewhat crude civilization, and it is easier to assume than the democratic dignity of Lincoln, who amid the distractions of the civil war signed the bill which laid the foundation for the university of his native state.



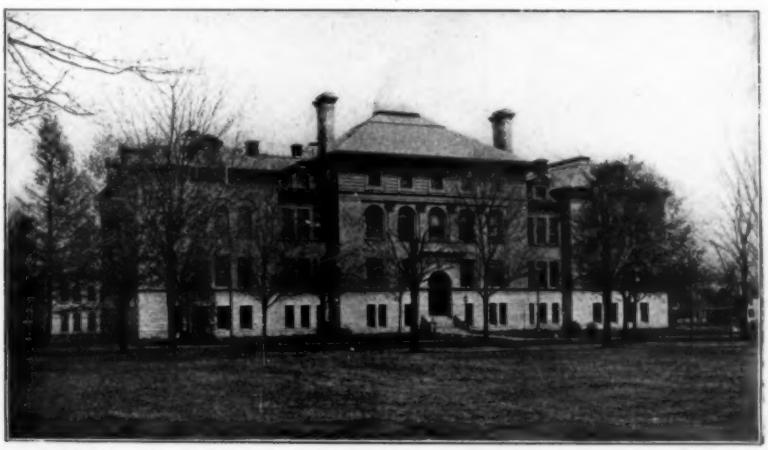
1, Men's gymnasium; 2, Armory; 3, Woodshop and foundry; 4, Metal shop; 5, Electrical and mechanical laboratory; 6, Reservoir; 7, Heating plant; 8, Pumping plant; 9, Applied mechanics; 10, Engineering hall; 11, Greenhouse; 12, President's house; 13, Library building; 14, University hall; 15, Natural history hall; 16, Law building; 17, Chemistry building; 18, Agricultural buildings; 19, Greenhouse; 20, Observatory; 21, Warehouse; 22, Veterinary building; 23, Insectary; 24, Woman's hall; 25, Mechanical engineering laboratory.

No one at that time could have foreseen the future of the university. Its growth did not begin so soon as that of Michigan and Wisconsin, but the three universities will soon stand in friendly rivalry to perform the greatest service, and will equal and may surpass Harvard, Yale and Columbia in number of students and probably in all the functions of a great university. It was only in 1885 that the Illinois Industrial University assumed its present name. The campus is shown in the accompanying illustration. There are now on it some twenty-five buildings, nearly all of pleasing architectural design, well-placed among grass and trees. Ten years ago there were in the university 550 students; there are now 3,594 students with 487 professors and other teachers. This remarkable growth, chiefly under the administration of President Draper, will doubtless be continued under the administration of President James.

Dr. James was born in Illinois in 1855. He was educated at the Illinois State Normal School, and later at Northwestern University, Harvard University and the University of Halle. He was principal of schools for four years, and in 1883 became professor of political science in the University of Pennsylvania, going in 1896 to the University of Chicago. Since 1902 he has been president of Northwestern University. He is the author of a num-

THE WOMEN'S BUILDING.

ber of books and papers on economic, public and educational questions, and has always taken a leading part in all movements for the advancement of his science and the extension of education. President James's views on education were clearly outlined in his inaugural address. He holds that the state university should be the central factor of the education in the state, but should cooperate with other institutions, public and private. He believes that the standard of the university should be continually raised, leaving to the colleges and schools the work of the lower classes and letting the university give 'the ultimate institutional training of the youth of the



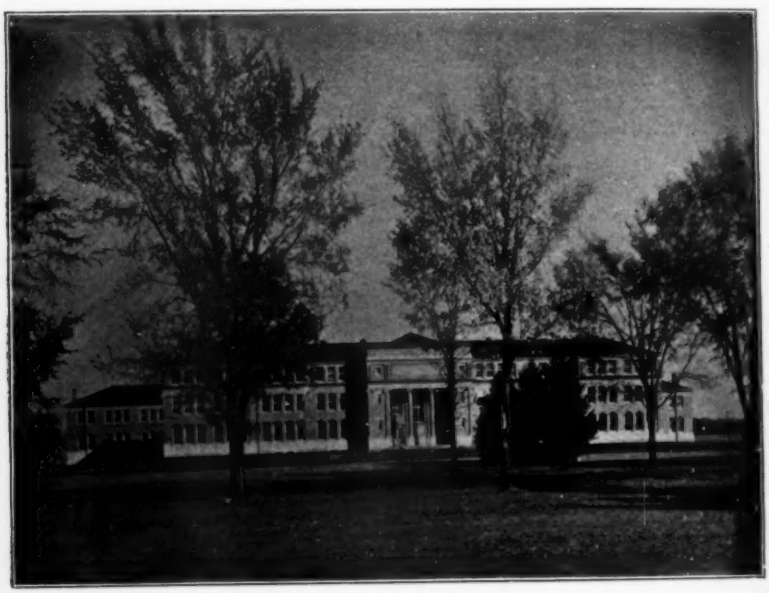
THE ENGINEERING HALL.

THE CHEMICAL LABORATORY.

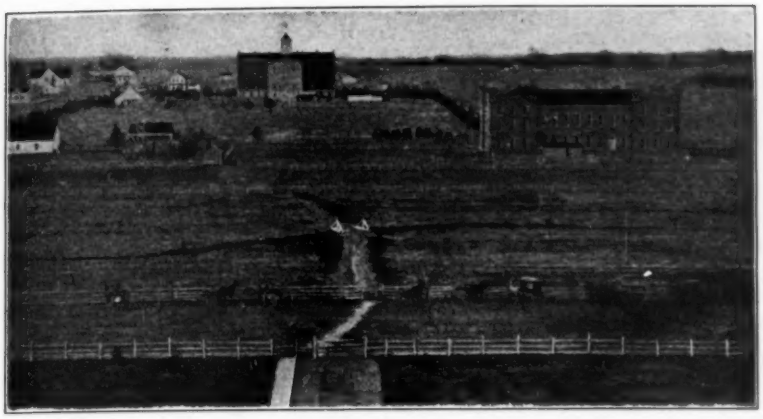
country for all the various callings for which an extensive scientific training, based upon liberal preparation is valuable and necessary.'

A CONFERENCE OF COLLEGE AND UNIVERSITY TRUSTEES.

ONE of the most interesting features of the program at the University of Illinois was the conference of trustees of American colleges and universities. The invitation to this meeting was itself a document of real educational significance as it outlined with clearness certain problems of deep concern for higher education in the United States. Thus it said: "In England the old universities are self-governing bodies, controlled largely by the faculties; in France and Germany they are departments of the government, and so far as they are not directly under the control of the government, they are autonomous, that is, ruled by the faculties. In the United States alone we felt it necessary to create a third organ, an independent, often self-



THE COLLEGE OF AGRICULTURE.



THE UNIVERSITY TWENTY YEARS AGO.

renewing body of non-experts, in whose hands the entire legal control has usually been placed"; and the first of the ten questions proposed for discussion was: "What should be the real administrative body of a college or university, the faculty or the trustees?"

The clear and frank statement of the problem in the invitation was maintained in the papers and discussions. Dr. Draper opened the conference with an eloquent address on the university presidency. He held that the chief duty of the trustees is to select a great man for president and thereafter to give him a free hand in all directions. He should be the supreme legislator, executive and judge. This point of view was questioned by Mr. J. P. Munroe, a trustees of the Massachusetts Institute of Technology, Professor Joseph Jastrow, of the University of Wisconsin, and Professor C. E. Bessey, of the University of Nebraska. It was argued that while the autocratic president may gather wealth and produce an efficient machine, such an officer is subversive of democratic ideals and true scholarship, tending in the end to demoralize the academic career.

Dr. Draper was careful to abstain from any laudation of what he had himself accomplished during his presidency of the University of Illinois, but the impressive material progress of the institution was evident on all sides, and was the strongest argument in favor of a benevolent despotism. It seems therefore fair to call attention to two facts. It is not certain that the University of Illinois is as great a center of education, scholarship and research as might be hoped from its generous support, and its material progress may have been due to a socialistic governor of the state rather than to an autocratic president of the university.

It is indeed on open question as to how far the increasing wealth of our universities, whether from private gifts or from legislative appropriations, is due to the office of the president. It may be that the office is the result of the fact that wealth and numbers have increased more rapidly than they can be assimilated. The ways of scholarship, like the ways of democracy, are slow; but creative scholarship and a free democracy are high ideals, not to be lightly sacrificed to machinery whose only possible use would be the attainment of such ideals.

THE DISTRIBUTION OF STARS.

MAN has speculated on the extent and structure of the visible universe ever since the beginning of history. But however ingenious and plausible some

PHOTOGRAPH OF THE MILKY WAY IN SAGITTARIUS AND ADJACENT REGIONS—SHOWING EXTREMES IN STELLAR DISTRIBUTION.

of the resulting cosmologies may be, they must, nevertheless, be regarded as little more than guesses, since the scientific data necessary to a sound conception of the problem are still lacking. The chief elements required are the determination of the number, distribution, constitution, brightness, distance and motions of the stars. All these determinations are now possible to science, at least in part, although only a few decades ago several of them would have seemed impossible.

A recent contribution of great importance in this line is a study of the 'Distribution of Stars,' by Professor Edward C. Pickering, director of the Harvard Observatory. The memoir forms Part V., Vol. XLVIII., of the *Annals of the Observatory*. This research was rendered possible only as a result of the extended work in stellar photometry which has been carried on by the author during the last quarter of a century. Nearly two million observations of the brightness of the stars have been made by him and his assistants at the Cambridge and Arequipa stations of the observatory. Upon these results especially, and also upon the various *Durchmusterungs*, and the work of Father Hagen, the investigation is based.

Two very important facts are brought out by this research. Hitherto it has been supposed that the proportion of faint stars to the whole number is much greater in the milky way than in other parts of the sky. This may still be true for very faint stars, but Professor Pickering shows conclusively that, for all stars whose magnitudes have been determined, the proportion of bright and faint stars is practically the same in the milky way as elsewhere in the sky, and that the stellar density is only about twice as great.

From theoretical considerations Professor Pickering derives the formula, $\log N = 0.60\,M + A$, in which N is the number of stars brighter than a given magnitude M. A comparison of the results of observation, however, shows that the coefficient of M is never greater than 0.52, and that this value, which is fairly uniform for the brighter stars, grows rapidly less for the faintest stars whose magnitudes have been determined. An inspection of Table XXI. of the memoir shows that for the stars visible to the naked eye, the whole number brighter than a given magnitude is from three to four times as great as that of the next lower magnitude; that is, for example, there are 3.3 times as many stars of the fifth magnitude and brighter, as of the fourth magnitude and brighter. For fainter stars the ratio steadily decreases, until for the twelfth magnitude the number is little more than twice that for the eleventh magnitude. This curve of distribution is remarkable. If the rate of decrease continues with equal rapidity for successive magnitudes, it would lead apparently toward the ratio unity at the eighteenth or twentieth magnitude, which would imply the limit—possibly very ill-defined—of our universe. This conclusion is, however, still very uncertain, since reliable observations of brightness are available only to the twelfth magnitude. Professor Pickering is careful to draw few conclusions beyond the reach of actual observation. He says, however, 'As estimates are given which are still more uncertain than these, it may be stated that the number of stars corresponding to the magnitude 15, or which would be visible in a telescope of 15 inches aperture, would be about eighteen million, and the increase for larger apertures would be surprisingly small.' With the mounting of the great five-foot reflector at Cambridge, however, there seems to be little doubt but that the determinations of brightness will be extended to the faintest stars which can be reached at the present day. Before many years we shall perhaps know whether our universe is simply a limited region in the infinite.

THE PROPORTION OF CHILDREN IN THE UNITED STATES.

THE Bureau of the Census has issued a bulletin on the proportion of children in the United States, containing valuable statistics secured at the last census and a discussion by Professor Walter F. Willcox, of Cornell University. There is unfortunately very little exact knowledge concerning the birth rate or the size of families in the United States; but in some ways the proportion of children to the total population or to the number of women of child-bearing age is more significant than the birth rate. The birth rate, which is usually given as the number of births each year per thousand population, is only significant when taken in connection with the death rate. The birth rate has been steadily decreasing in all civilized countries, and most rapidly in the countries that are regarded as the most civilized, but at the same time the death rate has been decreasing nearly in same proportion, so that the increase of population per thousand inhabitants has remained nearly stationary in recent decades. But these figures require further analysis. In so far as the decreased death rate is due to the saving of the lives of healthy infants, it can to real advantage supplement the decreasing birth rate. In so far, however, as the decreasing death rate is due to the prolongation of life beyond the age at which children are likely to be born, or in so far as it is due to saving the lives of children who are constitutionally feeble, the result in the next generation will be a sharp decline in the birth rate without any further decrease in the death rate. The size of family again is not significant unless taken in connection with the number of children that survive and the proportion of people who are married.

The number of children under five years of age compared with the number of women from fifteen to forty-nine years of age is given in the census, and these figures are perhaps as simple and convenient as any for the study of changes in the fertility of the population. They should, however, be correlated with the birth rate and death rate and the size of family, and require further analysis, immigration and alteration in the frequency of death at different ages being complicating factors. The bulletin shows that at the beginning of the nineteenth century the children under 10 years of age constituted one third and at the end less than one fourth of the total population. The decrease in this proportion began as early as the decade 1810 to 1820, and continued uninterruptedly, though at varying rates, in each successive decade. This of itself, however, is not enough to prove a declining birth rate, as the decrease in the proportion of children in the total population may indicate merely an increase in the average duration of life and the consequent survival of a larger number of adults.

But by taking the proportion of children to women of child-bearing age we are able to get a more satisfactory index of the movement of the birth rate. Between 1850 and 1860, the earliest decade for which figures can be obtained, this proportion increased. But since 1860 it has decreased without interruption. The decrease has been very unequal from decade to decade, but if twenty-year periods are considered, it has been very regular. In 1860 the number of children under 5 years of age to 1,000 women 15 to 49 years of age was 634; in 1900 it was only 474. In other words, the proportion of children to potential mothers in 1900 was only three fourths as large as in 1860. One is thus led to the conclusion that there has been a persistent decline in the birth rate since 1860.

A comparison is made between the proportion of children born of native mothers to 1,000 native women of child-bearing age and the proportion of children born of foreign-born mothers

to 1,000 foreign-born women of child-bearing age. In 1900 the former proportion was 462, the latter 710, the difference indicating the greater fecundity of foreign-born women. The comparison also indicates that the total decrease in fecundity of white women between 1890 and 1900 was the result of a decrease for native white women partly offset by an increase for foreign-born white women.

THE INTERNATIONAL CONGRESS ON TUBERCULOSIS AND PROFESSOR VON BEHRING'S ANNOUNCEMENT.

MEDICAL journals have now reached this country giving an account of the Congress on Tuberculosis, held in Paris, in October, of which the most dramatic episode was the announcement by Professor von Behring of an alleged cure for consumption. A report of his statement was cabled to the daily papers and was doubtless received with too great hope on some sides and too great scepticism on others. It will be remembered that when Professor Koch announced the discovery of tuberculin in 1890, the results did not fulfil the promises. It remains true, however, that tuberculin has proved a valuable method of diagnosis, and that it has certain remarkable effects on the tuberculous foci present in the body. These foci are in fact thrown off in matter that is dead so far as tissue cells are concerned, but which unfortunately still contain living bacilli, which are likely to be again distributed through the body. Modifications of tuberculin have been proposed by Koch himself, by Klebs, by Landmann, by Maragliani and by others, but never with results that have commanded the assent of the scientific world.

It appears that Professor von Behring's communication to the congress was made at the closing session, contrary to his intentions, as a result of pressure brought to bear on him in one way or another. His statement was so brief that such importance as it may have consists mainly in the facts that he announced that the details of his researches are in press for publication and his own confidence that he had found a curative principle for tuberculosis. This principle, to which he gives the name 'TC,' is obtained from the tubercle bacilli after various toxic portions, including Koch's tuberculin, have been removed. The substance is resorbable by the lymphatic cells, differing thus from the humeral immunity of the antitoxins. The state of immunity of the organism evolves parallel with the metamorphosis of the cells under the influence of TC. Professor von Behring has as yet only made experiments with laboratory animals, but he expects that the harmlessness and therapeutic value of the remedy will be demonstrated by clinicians within a year. Professor von Behring's announcement would be received with pretty complete scepticism if it were not for the fact that the curative effects of his diptheretic anti-toxin have been accepted by the medical world.

It appears that no other papers of special importance were presented to the congress. The time was spent largely in receptions, dinners and excursions, the last mentioned being of much value to the delegates as illustrating the most advanced French methods of treating tuberculosis. The next meeting of the congress will be in Washington in 1908, the invitation being presented by Drs. Flick, Jacobs, Beyer and Knopff.

SCIENTIFIC ITEMS.

WE regret to record the deaths of Sir William Wharton, F.R.S., hydrographer of the British Navy; Major General Sir Charles Wilson, F.R.S., director-general of the British Ordnance Survey; Dr. Sylvester Dwight Judd, formerly assistant biologist in the U. S. Department of Agriculture, and Dr. Wilhelm Johann Friedrich von Bezold, professor of physics and

meteorology at the University of Berlin.

THE Bolyai prize of the Hungarian Academy of Sciences has been awarded to M. Poincaré.—The eightieth birthday of Dr. F. A. March, professor of English and comparative philology at Lafayette College, was celebrated on October 25, when Professor W. B. Owen made an address of congratulation. The trustees of the college have offered to retire Professor March with full salary, but he prefers to continue his usual duties.

PROFESSOR ROBERT KOCH, who has been at Amaris in West Usambara and at Uganda to complete his researches on trypanosomes and sleeping sickness, expected to reach Berlin on October 23.—Dr. Arthur Stähler, assistant in the chemical laboratory of the University of Berlin, has been sent by the minister of education to Harvard University to pursue studies in inorganic chemistry under Professor T. W. Richards.

THE inaugural meeting of the British Science Guild was held on October 30, at the Mansion House, London. The objects of the guild are (1) to bring together as members of the guild all those throughout the empire interested in science and scientific method, in order, by joint action, to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavor, and thus to further the progress and increase the welfare of the empire; (2) to bring before the government the scientific aspects of all matters affecting the national welfare; (3) to promote and extend the application of scientific principles to industrial and general purposes; (4) to promote scientific education by encouraging the support of universities and other institutions where the bounds of science are extended, or where new applications of science are devised.

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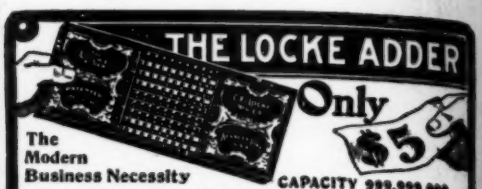

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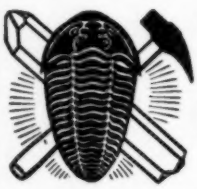

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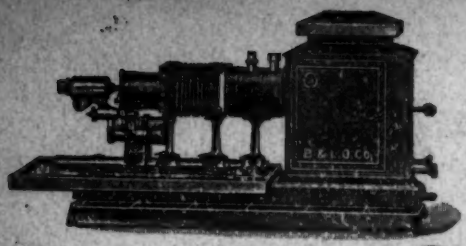

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